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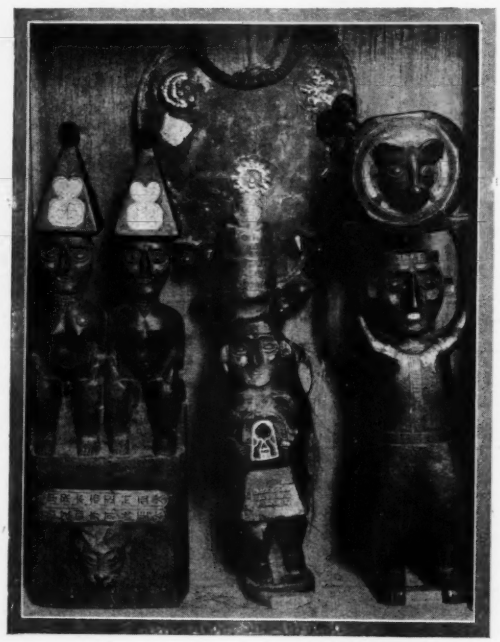
A Monthly Popular Journal of Knowledge

Vol. VIII, No. 91. JULY, 1927. PRICE 1s. NET



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DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. VIII. No. 91. JULY, 1927. PRICE 1s. NET

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Editorial Notes.

The cables from China are so much occupied with military and political news that it is difficult to learn how far the present situation is affecting cultural activities in the East. A note that has just reached us from Shanghai sheds light in describing how the restive attitude towards the foreigner is reflected in increasing extent in matters which ought to be regarded as outside the sphere of controversy. It appears that certain scientific organizations in Peking have formed an association to fight the efforts of the various foreign expeditions searching for remains of ancient man and other treasures of geological and archaeological interest in different parts of China. The view is held that Chinese relics should be explored only by the Chinese people themselves. Particular exception appears to have been taken to the recent expeditions of the American Museum of Natural History, some members of the association having gone so far as to demand the return to China of the one-million-year-old dinosaur eggs discovered in Mongolia and taken to America. Discussing this manifesto in the *China Journal* of which he is editor, Mr. Arthur Sowerby, who has probably done more than any Englishman in recent years to further the interests of scientific research in China, states that in so far as the movement aims at retaining in the country valuable evidence and actual relics of a bygone age, he feels considerable sympathy with it. Left to the Chinese, on the other hand, he asserts with authority that the local information imperatively required to fill in the gaps in our general knowledge of archaeology and the various sciences would be withheld indefinitely—the financial state of China alone preventing adequate exploration. We sincerely echo the plea with which Mr. Sowerby concludes his article, calling on Chinese scientists to exert all their influence against the introduction of politics and race prejudice into the sphere of knowledge, preserving thereby the established principle that science knows no country.

* * * * *

By an amusing coincidence the possibility of crossing from Europe to America in two hours was discussed in our June issue, which was on sale just after Colonel Lindbergh, flying alone, had crossed the Atlantic in less than two days. At the moment of our going to press the young American was being widely criticized for proposing to court what was regarded as certain disaster, and from the newspaper reports which explained how "the flying fool" was neglecting even ordinary precautions, it was difficult in advance to think otherwise. When, however, the successful airman had faced the ordeal of the crowds assembled at Le Bourget, and the more elaborate congratulations that followed in Paris and London, it became evident that the feat had not been accomplished without considerable forethought, which only his modesty had obscured. While no amount of preparation, in the present state of our knowledge, could in any way diminish the tremendous risk of such a flight, the quiet confidence of the young American undoubtedly contributed much to its achievement.

* * * * *

We refer in the previous paragraph to an article last month which advanced a new proposal to fly with rocket-apparatus. In this a German scientist suggested that in the regions of space outside the gravitational attraction of the earth a rocket might travel at such a rate that America could be reached in less than two hours. Notwithstanding our explanation in publishing the scheme that it could not at present be regarded as a practical one, we found ourselves reflecting when it was at once ridiculed

by the *Manchester Guardian*, that the achievement of almost every scientific discovery has at one time been pronounced impossible. "It seems," this newspaper commented in a leading article, "the sort of trip which, if it is ever tried, might fairly be offered to condemned criminals as an alternative to the gallows." Without stressing the admittedly slight similarity of the rocket and the aeroplane, we may recall that just twenty years ago the majority of people pronounced the first attempt to fly from England to France, in July, 1907, as "essentially rash and absurd." Now, within a few weeks of Lindbergh's unprecedented achievement, the Atlantic has again been crossed, by Mr. Chamberlin and Mr. Levine, on a flight which sets up a "non-stop" record of over 4,000 miles.

* * * * *

Further results of the researches on wool now being carried out at Leeds University have been announced since we published last month an article on sheep breeding by Dr. Dry, of the Textile Department. Oils, of course, play an essential part in woollen manufacture, in facilitating the passage of the fibres one over another in combing and carding, and for this process they must have certain special properties, such as not being easily combustible in use. Olive oil has been generally used, but now a blend has been discovered which is a first-rate lubricant and at the same time less costly than many of the existing oils on the market. Details will be made public in due course.

* * * * *

On 29th July a conference will open at Oxford on "Shakespeare and the England of His Time," the main subject of study chosen for the summer meeting to be held, as usual, under the auspices of the Extension Lectures Committee of the University. The programme provides so unique a summary of the outstanding problems with which our knowledge of Shakespeare is at present concerned, that we shall publish in August a "Shakespeare Number," containing details of the conference and some special articles. It has been arranged, for instance, with the Master of Jesus College, Cambridge, to contribute a paper answering the objections which have been raised to his startling new theory of Shakespeare's education which was recently reviewed in *Discovery*. The subjects announced for discussion at Oxford include not only the principal plays themselves, but their relation to the stagecraft and audiences of the period, Shakespeare's London being the topic of four lectures. Tudor architecture and music are to be described with illustrations, while the "Everlasting Question" will be dealt with by Principal L. P. Jacks, of Manchester College. Miss Lilian Baylis, manager of the "Old Vic," is to speak on "Shakespeare for the People." Tickets for the whole meeting, which is divided into two parts, from 29th July to 8th August, and to 18th August, can be obtained for two guineas (one part only, thirty shillings) from the Rev. F. E. Hutchinson, M.A., Acland House, 40 Broad Street, Oxford. Working men can obtain tickets at half price through the Workers' Educational Association, 16 Harpur Street, London, W.C.1.

* * * * *

We learn with interest that Mr. Allen French, who wrote the article in our April issue on "Discovering American History in England," is again in this country in the hope of making discoveries similar to those recorded. He informs us that from the beginning his further visit has been fortunate, in that he has been given permission to study a large collection of documents not open to the general student. Mr. French's period is from the beginning of the American Revolutionary War at Concord and Lexington, to the evacuation of Boston, a period which includes the battle of Bunker Hill. It will be remembered from his article that he believes a proper understanding of the subject requires a close study of the various points of view held at the time among all classes in the mother country. The same holds true of the study of actual events at the seat of war, where the general military operations have long been known, but the experience of participants, especially among the British, has not yet been fully brought to light. For this reason our author welcomes every chance to study English letters and diaries, and particularly those of the fighting men who were in New England between March of 1775 and April of 1776. Mr. French may be addressed in care of Brown, Shipley & Co., 123 Pall Mall, London, and we can from personal knowledge assure owners of such papers that every care will be taken to observe their rights.

* * * * *

As six months have elapsed since the publishers of *Discovery* acquired the goodwill and connexions of *Modern Science and Conquest*, it is appropriate to thank our many new readers for their continued interest, by which a permanent connexion has now become established. For the benefit of those who may still be unaware of the "change over," we may remind readers that we are always glad to send a free specimen copy, to any of their friends who are likely to be interested. We may also announce that in response to many suggestions we shall introduce in our next issue a summary entitled "The Month in Brief," which will deal with discoveries for which space is not at present found in these columns.

Judging Old Pictures: Some Turners Rediscovered.

By C. E. Hughes.

Author of "Early English Water-Colour."

Following a discussion on the genuineness of a collection of paintings at Bruges, a controversy has been taking place among art experts on the methods of judging old pictures. The procedure in the related field of water-colour forms the subject of this article, in which the story of how recently two Turner drawings were rediscovered is told for the first time.

"FINDS" in the way of pictures divide themselves naturally into the two classes "discoveries" and "rediscoveries." A discovered work is one which was hitherto altogether unknown; a rediscovered one is one of which there is historical record of existence, but which has passed into unknown ownership. In general terms it is a simpler matter to be sure of a rediscovered work than of one which is new to expert students of the artist to whom it is attributed. With the "discovery" it is necessary to demonstrate the existence of signs of the painter's inspiration. These may happen to be so clearly evident that they cannot be reasonably disputed, but it may also happen that they are such as to be recognizable only by one who has an exceptional sympathy with the painter's attitude of mind. With a "rediscovery" there is more definite evidence. There is, for a start, knowledge that the work existed, and there are in many cases engravings and photographs of it. The rediscoverer's work therefore resolves itself into satisfying himself and others that the rediscovery is not a copy made by a contemporary pupil, by a later student, or by a forger. It may be said that copies are as a rule not difficult to detect, for a painting in which every stroke must be restrained within prescribed limits can never reproduce in every particular the freedom of an original.

The Master's Touch.

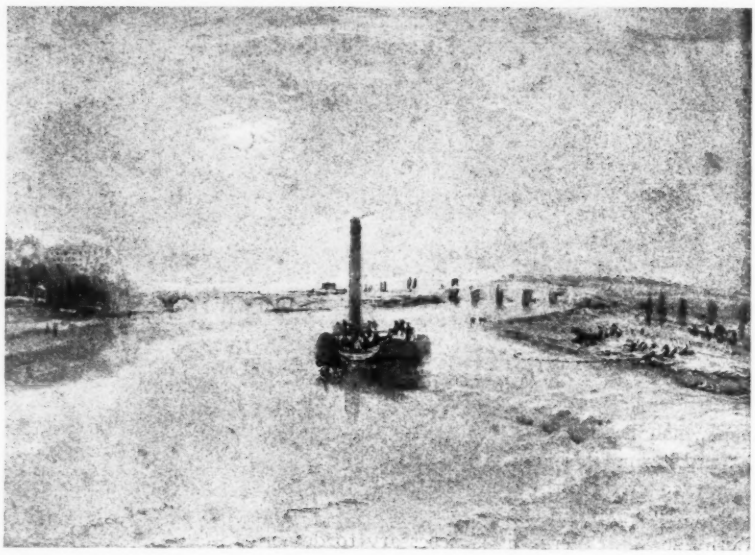
In the analysis of a "discovery" several more or less matter-of-fact questions must be answered. Is the subject a likely one? Is the colouring in the artist's usual manner? Are the materials old enough? And so on. But there is another question which can alone satisfy the expert—Is the *touch* authentic?

A great artist's method of manipulating his pigments is more than anything else individual. Mere excellence of technique may reveal nothing, for quite competent artists have been known to descend to deliberate forgery. A profound study of the master's own touch as revealed in works of undoubted genuineness can be regarded as the only basis for an absolutely reliable verdict. And even here one can hardly be completely certain in every case. All artists have occasionally varied in their quality. One may quote as an example a water-colour in the British Museum which for a long time was attributed to Bonington (1802-28), but at length someone noticed that it was on paper with a watermark dated several years after Bonington's death. It is a slight sketch, and but for the fact of the date it would be almost impossible to declare with complete conviction that it is or is not by Bonington.

Scientific Evidence.

Clearly it is futile to proceed with an investigation if the picture can be proved to have been produced after the death of the artist to whom it is attributed. Science can do something in this direction. Chemical analysis and the microscope may demonstrate that the materials employed in a supposed old master are of modern manufacture, and only the other day the Editor of *Discovery* reminded readers of *The Times* of researches by American experts, which showed that the X-rays are capable of penetrating paints of a vegetable character and revealing an under-painting in older pigments of metallic composition. Science can certainly draw certain broad incontrovertible conclusions of this nature which will be invaluable to the art critics. But although the scientific analysis of old pictures is still, so to speak, in its infancy, there are already signs of disagreement as to the exact deductions to be made from minute particulars. If the preliminary questions can be settled definitely there is no room for doubt. If not, the critic's sense of the artist's touch must be regarded as the final test.

A signature is perhaps of all the least reliable piece of evidence. Forged signatures capable of deceiving most people but experts are comparatively easily produced, though with many collectors they have a quite unjustified value. Forged signatures, indeed sometimes appear on perfectly genuine paintings which were left unsigned by the artist. I know of a Corot (1796-1875) of this kind. The signature had been added afterwards by an unscrupulous dealer to make the picture more saleable. Probably the X-rays would not detect the fraud in so recently painted a picture as a Corot.



"THE CONFLUENCE OF THE SEINE AND MARNE." J. M. W. TURNER.

Painted by Turner among the originals for a series of engravings of the "Rivers of France," this drawing afterwards disappeared for nearly seventy years. It is here photographed for the first time since it was discovered again recently, by permission of its presen owner.

What, then, is this matter of touch? One can best describe it, perhaps, as the artist's professional handwriting. It is practically the same thing in painting as the individuality of handwriting. Every specimen of mature handwriting may have features of similarity to some other, but it always embodies certain characteristics which render it unmistakably recognizable by those who are familiar with the writer's caligraphy. It would be a very unusual thing to find two specimens of handwriting by different people so absolutely alike that they were indistinguishable under expert examination. I have no experience of the methods adopted for the authentification of old manuscripts, but I assume that one could apply to them very much the same tests that can be applied to old pictures. If a manuscript were discovered which purported to be the original version of an unknown essay by Charles Lamb it could be tested first along certain obvious lines. Definite anachronisms would condemn it immediately. Lamb, for instance, might conceivably have written an essay on Dickens's parliamentary reports or his earliest contributions to the *Monthly Magazine*, but hardly on "Pickwick," which was not begun until two years after Lamb's death. The paper and ink used would have to be contemporary. The phraseology would have to be that of Lamb. All these things might in exceptional circumstances be imitated by a skilled and learned forger. William Henry Ireland, indeed, actually did deceive the literary world for a quite considerable period with his Shakespearean forgeries. Comparison of the handwriting was impossible, for apart from signatures there is no known authentic manuscript by Shakespeare in existence, and the fraud, though suspected, was only finally revealed on Ireland's own avowal. I venture to think that the only final test can be that of the actual writing, and if the specimen were only fragmentary erudition in alliance with fraud might triumph even here. So also with a picture. In both cases it must be allowed that there are limitations to the possibility of complete certainty.

The authenticity of a "discovery" must therefore remain to some extent a matter of opinion. There is no exact science which lays down the laws (if there be such) which differentiate minute peculiarities of technical manipulation. Still less can any laws governing the evidences of inspiration be reduced to a code.

With these general remarks by way of preface let me tell the story of two "rediscovered" Turner water-colours. It should be mentioned that though Turner was extraordinarily prolific, his work has been pretty fully documented. Mr. A. J. Finberg's "Inventory" of the drawings in the Turner Bequest contains over 19,000 items, and hundreds of other drawings and paintings are known to be in private hands. Nevertheless, from time to time unknown Turners come to light and there are also "rediscoveries." Many of Turner's well-known water-colours were painted on commission and passed immediately out of his hands; others were done for engraving as illustrations for books. Drawings executed in this way were usually hired out to the engravers and returned to the artist after the plates were engraved. Many of these remained with him until his death, when they passed to the nation. Some of the finest drawings in the series of sixty-one engraved for the "Rivers of France" series are thus to be seen in the Tate Gallery. Others are in the Ashmolean Museum at Oxford. A very few of the remainder, perhaps not more than three or four of them, got into private hands. Two of these, "The Confluence of the Seine and Marne" and another, were sold at Christie's

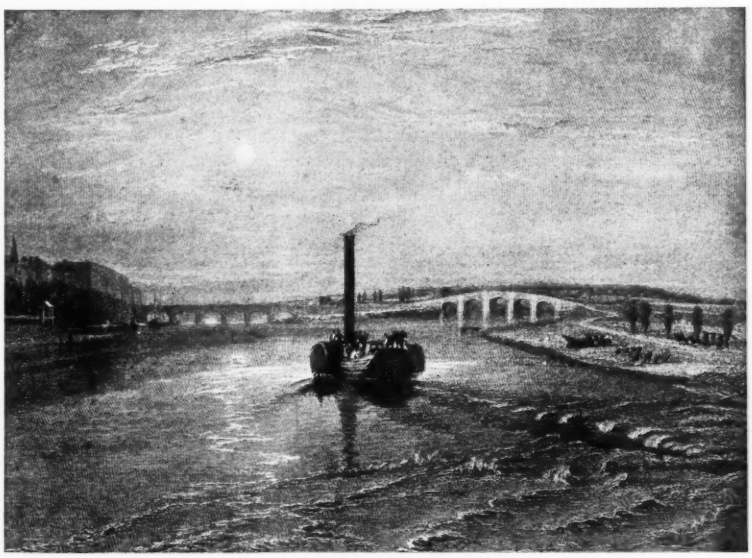
in 1852, and this fact has been duly noted by writers on Turner. After that date the record is blank.

In 1915 the "Confluence" drawing and its former companion appeared once more in a Christie sale. They were in frames with soiled mounts covered with glass, round the edges of which dust had penetrated. To any but the very alert eye they seemed hardly worth a second glance, though in the catalogue they were correctly described. One of the best living judges of Turner's work bought the two in one lot for five guineas. But even he was at first not sure of them. Really believing in them in his heart, he found it so incredible that two authentic originals from the "Rivers of France" series could pass so ignominiously through the sale-room that he doubted his luck, and even blamed himself for being foolishly extravagant in wartime. He took them home, hid them in a cupboard, and waited until he could show them to a friend (then on military service) on whose judgment he could rely. The drawings were taken out of their frames, minutely inspected, and compared with the engravings, and the verdict was unequivocally in their favour.

On the opposite page the "Confluence" drawing is reproduced, and in the plate below is shown the engraving which was made from it. The drawing is a typical example of the big group, more or less elaborately finished, which Turner made during his tours in France from 1826 to 1833. They were on blue paper and were generally sketched in with pencil and chalks and elaborated with water-colour, both opaque and transparent. The drawings engraved in the "Rivers of France" series were in most cases actually those made by Turner on the spot, though doubtless some subsequent touches were added. Many of them, that is to say, were not worked up at home from sketches and studies as was the case with other of Turner's engraved drawings. Owing to the nature of the medium they were exceptionally liable to damage in handling and in some of them, as may be seen by comparison of the engravings with the originals exhibited in public collections, the chalkwork has suffered. It must be remembered, however, in making such a comparison, that Turner frequently guided and instructed his engravers, and this is more uniformly the case with the "sketchy" "Rivers of France" series than with his earlier engraved drawings which are elaborately finished down to the most minute particular.

These considerations will account for the lack in the original "Confluence" drawing of some of the detail which appears in the engraving. The absence of colour also naturally deprives the reproduction of much of the subtlety of tone which appears in the original. The drawing has, moreover, certainly suffered since it left Turner's hands. Probably at some time or another a former owner has made clumsy attempts at "cleaning" and has removed in the process a good deal of Turner's more delicate work.

But quite enough of Turner's touch or "handwriting" remains to provide unquestionable proof of authenticity. As Ruskin remarks in discussing this drawing in "Modern Painters," almost any artist would naturally have indicated the churned-up water in the wake of the steamer, but probably only Turner would have thought of showing the phenomenon of this wash from the paddles being thrown back by the river bank and forming a series of conflicting wave circles. But even if another artist might have thought of this, only Turner could have sketched it in—for the drawing is really a sketch—in quite this way. Similarly there are touches—put in with evident speed and masterly suggestiveness



ENGRAVING DONE FROM THE DRAWING REPRODUCED OPPOSITE.

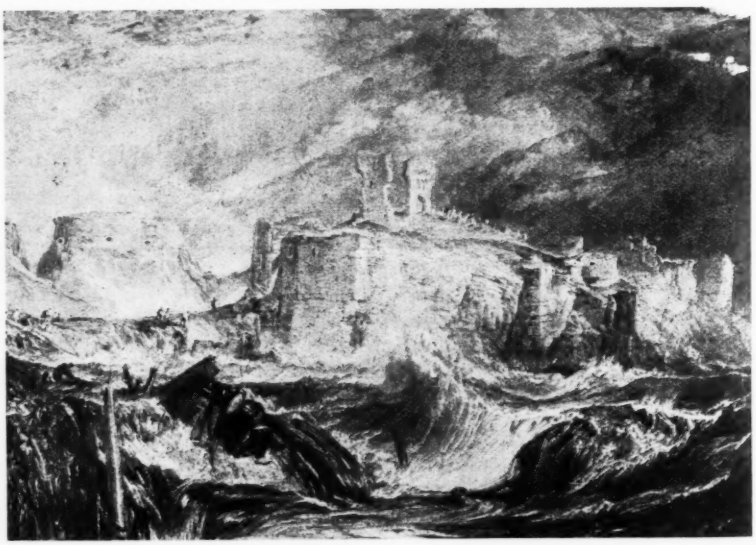
In comparing these pictures, it must be noted that not only was the engraving in the case of the "Rivers of France" series probably carried out in greater detail than the original sketches—which were drawn during tours in France from 1826 to 1833—but the artist frequently guided and personally instructed the engravers himself.

– in the figures hauling the net, in the stage coach, and in the steamer with its crowd of passengers. They are touches made unmistakably with all the magic directness of the Turner manner. Exactly why these touches are unmistakable it is very difficult to explain, but to those who are familiar with Turner's sketches they actually are as unmistakable as the handwriting of a friend's letter.

We have with the "Confluence of the Seine and Marne" an example of a drawing of which the printed record of ownership had definitely come to an end some seventy years ago. With the second drawing there is the rather curious case of one of which the ownership was generally believed to be known. It came to light in more romantic circumstances than the other. One might reasonably expect to find Turners at Christie's, though hardly to find them there practically discredited. But one does not expect to come upon a fine water-colour by him pasted into an album in a second-hand bookshop. That is where this one was discovered.

The bookseller had bought the album with the rest of the bound volumes of a library, and on examining it he found that it contained a number of water-colours, the majority of which were signed or else had the names of the artists written in the margin. One of the drawings had the name J. M. W. Turner under it. The bookseller being no judge of Turner's or, indeed, of any other artist's work, decided to test the authenticity of the drawing by putting the album into a sale with an indication of the fact that it contained a drawing attributed to Turner. He fixed a reserve on the lot and in due course it came back to him, no bid having reached the required sum. It was then placed in his stock at a slightly higher figure. At this price it was bought by a collector of water-colours who, having visited the shop with a book collector, had asked casually by way of passing the time if the bookseller happened to have any old drawings such as are sometimes to be found in print shops. The album was produced and the supposed Turner was pointed out. The collector felt that it was genuine, but conflicting with his judgment was, as in the case of the "Confluence" drawing at Christie's, the conviction that the thing was too good to be true. It was not, however, difficult for him to make up his mind for the album contained several other interesting drawings, one of which, a view of a harbour by Sir A. W. Callcott, R.A., might reasonably be considered to be worth the price asked for the album. Anyhow, he took the risk, and close and leisurely examination convinced him that he had not made a mistake.

There is in it a wealth of detail, so minute that it can scarcely be discerned with a magnifying-glass, and yet so wonderfully ordered that it never "jumps" from its allotted place in the composition or appears to be too "niggling." This was never done quite in this way except by Turner. We have as the main idea a wreck on a rocky coast. Wherever the eye may travel—you can in imagination almost count every step of a long walk round the cliffs—you will see innumerable incidents, but never one that does anything but emphasize and assist the big dramatic effect. This point need not be elaborated; the reader can follow it out unassisted. What, however, cannot be adequately discerned in the reproduction below is that this mass of relevant detail is never carried out in the spirit of the miniature painter. Each feature is suggested rather than defined, and the suggestions are conveyed with an unerring freedom of brushwork which indicates the master and defies the copyist. If this drawing is the work of a copyist



"DUNBAR." J. M. W. TURNER.

The circumstances of the rediscovery of this water-colour (never previously photographed) are even more romantic than those of the other Turner drawing which forms the subject of this article. The tartan-clad figure seen clinging to the boat was one of the preliminary factors in identification.

ENGRAVING FOR SCOTT'S "PROVINCIAL ANTIQUITIES."

This was published in Sir Walter Scott's "Provincial Antiquities of Scotland," though the water-colour opposite which was identified from it presented the problem that it had not been among the other originals known to have been in the possession of this famous author.

then I am convinced that he must have painted most of the Turners in existence, just as Bacon wrote Shakespeare.

Satisfied that the drawing was a genuine Turner, the purchaser's next task was to find out whether it was a discovery or a rediscovery. It had all the appearance of one of the drawings done for engraving, and if such an engraving existed, the Scottish subject, indicated by the tartan-clad figure clinging to the boat, suggested Sir Walter Scott's "Provincial Antiquities of Scotland" as the most likely place to look for it. For this two-volume work Turner did ten full-page plates and two vignettes for the title pages. Reference to it revealed the fact that the engraved view of Dunbar was identical with the drawing. Moreover, in the same volume appeared an engraving of Leith Harbour, after the Callcott water-colour, and also one after an architectural drawing by Edward Blore which was another of the drawings in the album. There certainly seemed to be here something of value as circumstantial evidence, for three originals by different artists for plates in the same book could hardly have come together entirely by chance.

But the search now encountered a check. The Turner illustrations to "Provincial Antiquities" are known to have been in the possession of Sir Walter Scott himself, and they are, in fact, the set usually called the Abbotsford Turners. It is also an established fact that after Scott's death the Abbotsford Turners came into the possession of Mr. T. Brocklebank. This situation presented a problem to which there were two alternative solutions: (*a*) either the rediscovered "Dunbar" was a copy or (*b*) the Abbotsford set was not complete. Convinced that the "copy" theory was untenable, the owner looked up the records and to his dismay found that in Rawlinson's "Engraved Work of J. M. W. Turner" the Dunbar drawing was definitely stated to be in Mr. Brocklebank's ownership. But further search brought to notice a catalogue, which Mr. Brocklebank himself printed and circulated, detailing all the pictures and drawings in his collection. In this the Dunbar drawing was not included. Mr. Brocklebank had eight only of the Turners in question, and as they were still mounted and framed—all the eight together—exactly as they had come from Abbotsford, it was evident that Scott had owned only eight.

Lockhart's "Life of Scott" throws further light on the matter. Here it is stated that Scott declined all pecuniary recompense for his work in connexion with the "Provincial Antiquities," "but afterwards, when the success of the publication was secure, accepted from the proprietors some of the beautiful drawings by Turner, Thomson, and other artists which had been prepared to accompany the text." With this statement it is unnecessary here to attempt to trace the genesis of the error. Somehow it came into existence and writers on Turner got into the habit of accepting it without question. Even historians are human. If they were not the sport of tracking down old masters might be deprived of many of its thrills.

How the "Dunbar" drawing found its way with those by Callcott and Blore into an album, it is possible only to conjecture. Such albums were in the early days of Queen Victoria common objects of the fashionable drawing-room, though, it is true, they seldom contained Turners. This one may have belonged to a member of the publisher's family, a young lady possibly, and one can picture the pride with which she used to show it to her friends. But perhaps even at that early date it had been already forgotten.

Exploring the Coral Reefs of Tahiti.

By Cyril Crossland, M.A., D.Sc., F.Z.S.

As a result of more than a year's research in the southern Pacific, the author has discovered many interesting details as to the structure and history of the coral reefs of Tahiti. He suggests an explanation for the occurrence of lagoons and throws new light on a number of other problems.

THE islands of the Society Group, situated in the Pacific about two thousand miles to the east of Fiji, are all ringed round by coral " barriers " in a remarkably complete and regular way. Except in the case of the largest island, Tahiti itself, the only gaps are the passes, which are just wide enough to admit ships to enter to the lagoons within the reefs (see Fig. 1). Generally these lagoons are wide and deep enough to make perfect harbours, but in places the reefs are continuous from shore to ocean, though little narrower than where the lagoon is fully developed. There is thus a variety in these reefs around Tahiti exceeding that to be found, for instance, in hundreds of miles of the coasts of the Red Sea or of equatorial East Africa.

The exploration, of which the following is a preliminary account, was made possible by funds provided by the Government Grants Committee of the Royal Society and the managers of the Balfour Fund of the University of Cambridge. Though the usual spelling of the name Tahiti is used above, I have hesitated between it and Tahaiti, which is phonetically correct. It is certain that Captain Cook's " Otaheite " was meant to be pronounced in this way, omitting the " o " which is merely the Tahitian for " it is."

The first step towards understanding the reefs is the examination of the origin of the island and its history, what elevations and depressions it has undergone, how far altered from its original form by the erosion of rain and rivers, the changes, if any, in the characters of its rocks, as well as its relations to the nearest continent and to the ocean around it.

The Society Islands are purely oceanic ; in spite of various assertions to the contrary no rock of continental type has been discovered nearer than Fiji, which represents the easternmost relic of any ancient continent of which we have any geological evidence. All the Society Islands are the eroded remains of volcanoes, generally with crater valleys easily recognizable, but erosion has gone much further in most of them than in Tahiti, in which the slopes are of typical volcanic form, and the valleys cut deeply into them are still so narrow as to be best described as great ravines (see Fig. 4). The newest volcano of all is the little island of Meetia to the south-east of Tahiti, which, though long extinct, is practically an unaltered cone. All the islands have a second feature equally striking as the reefs, namely, a strip of flat land running round the base of the mountains between them and the lagoons. As the whole of the (present) population and the famed fruitfulness of these islands are confined to these narrow strips of maritime flat, they constitute the entire social and economic importance of the islands. We shall see that they owe their existence to the coral reefs, and therefore that the evolution of the branch of the Polynesian race which inhabits

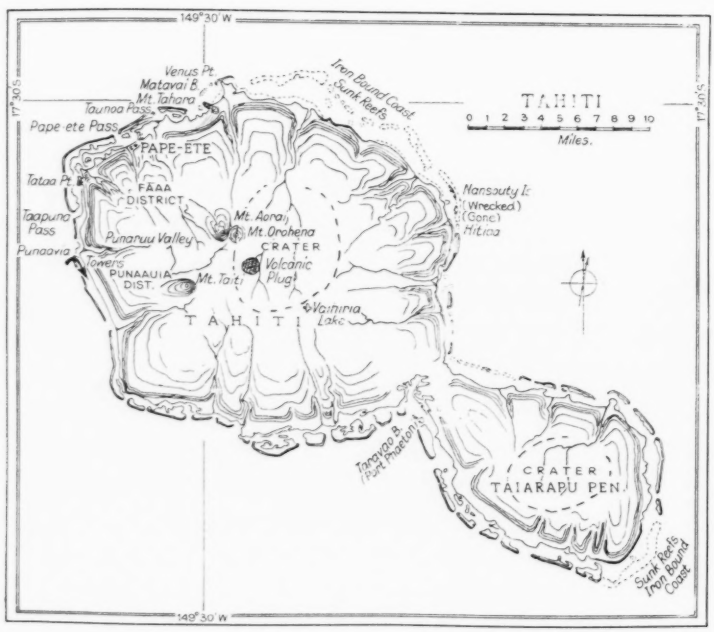


FIG. 1.
CHART OF TAHITI SHOWING ARRANGEMENT OF THE CORAL REEFS.
All the Society Islands are the eroded remains of volcanoes, of which the craters are here indicated. The view in Fig. 2 was taken from the point on the west coast marked by an arrow.

FIG. 2.
PANORAMIC PHOTOGRAPH ON THE WEST COAST OF TAHITI, SHOWING THE TYPICAL FEATURES OF THE ISLAND.
Part of the crater edge of Mount Taiti is seen on the left, descending by regular volcanic slopes to the ancient sea cliffs. Below these is the narrow strip of palm-covered flat, the only inhabited part of the island, which faces the calm lagoon. The surf here breaks nearly a mile out to sea on the coral reef.

them has depended upon the growth of organisms almost the farthest in the scale of life from man—the corals.

The structure of Tahiti is shown in the panoramic photograph of the west coast (Fig. 2). The calm lagoon, bounded seawards on the right by the white line of the surf on the reef edge; the palm-covered flat extending from the left foreground to the central distance, above which are the long slopes culminating in Mount Taiti, a remnant of the crater lip here only 4,500 feet high. Yet another feature is striking, the truncation of the ends of the slopes above the maritime flats, once cliffs cut by the ocean waves, now high and dry and nearly a mile from the nearest surf. From the human point of view this flat *is* Tahiti, and the calm lagoon is the most beautiful as well as the most characteristic feature of the island. The whole interior is a mass of the wildest mountains, entirely uninhabited and practically unknown. Though so thick with jungle as to be almost impassable, it is full of streams with no lack of fish and prawns; and while the ravines and cliffs are rich with fruit and edible roots, it is as difficult to penetrate as the deserts of the Red Sea, and far more difficult to explore. The smooth outer slopes are dry, and covered with hard fern resembling bracken; they are cultivated in a few places by the Chinese, but no native lives away from the flat.

Compare this elevation with the chart (Fig. 1). The point from which this typical photograph is taken is indicated by the arrow below Punaavia, but from any corresponding position a similar scene presents itself. Note the concentric arrangements of the reef, maritime flat, and crater walls, which are duplicated in the peninsula of Taiarapu, another smaller but perfectly similar volcano which has made contact with that of Tahiti by a long lava flow.

There are breaks in the ring of reef and maritime flat, and here, as seen in the view of the north-east coast (Fig. 3), Tahiti as we know it no longer exists. As wild as the other is peaceful, this coast might well be in another island; black cliffs fall into an unprotected sea, beaten by the ocean surf which round the rest of Tahiti breaks a mile from land on the living coral. Only here and there along this coast are remnants of reef supporting patches of flat bearing a few palms, but practically all this north-east quarter is without inhabitants.

FIG. 3.
DIFFERENT CHARACTER OF THE NORTH-EAST COAST.
Here the ocean surf breaks on the ironbound shelf at the base of the cliffs instead of a mile from land on the coral reef, which has been broken away. This exposed part of the coast is uninhabited.

Yet even here the reef exists, and is discovered by soundings under about five fathoms of water.

The photograph, however, shows that this description needs an amendment, for the cliffs do not

FIG. 4.
TAHITI, SHOWING THE ORIGINAL VOLCANIC CONE.
In this diagram the present island is sketched in relief, the volcanic cone of which it is the remnant being represented in flat shading. The various features are indicated by arrows.

drop into the sea quite directly, but their bases are separated from it by a narrow shelf of rock six feet or so above the water. The sea which once cut these cliffs out of the slope no longer does so, but has gone back and is now cutting into the shelf at their bases. Evidently either the island has risen a little out of the sea or the ocean level has itself fallen. As similar shelves are found at the bases of cliffs in many Pacific islands– *e.g.*, Samoa and Rapa, to mention two distant instances to east and west– the latter supposition is the more probable, though what may have been the cause is not clear, but is probably the accumulation of water at the poles in the form of ice. There are numerous traces of this change of level on the reefs, though in Tahiti there is *no* coral rock elevated so high above sea-level as to form dry land, a great contrast to my previous experience in tropical East Africa and the Red Sea, where greater reefs exist above than at sea-level; indeed, in nearly all coral seas elevated reefs are frequent. The nearest to Tahiti is the island of Makatea, one hundred and twenty miles to the north-east, which is a mass of coral limestone elevated to two hundred feet above the sea. Besides the fall of sea-level which exposed the bases of the cliffs there is in Tahiti no other indubitable record of changes of level.

Figure 4 is an attempt to reproduce the original volcanic cone of which the present island is the remnant, the drawing in relief indicating the present island, cut out into maintain peaks, of which the highest is still over seven thousand feet, separated by great gashes cut by rivers, while the flat shading represents the original wide-cratered volcano. This must have been among the largest in the world; it is to be borne in mind that though Tahiti is a mere dot on the map it is as large as the English Lake District (and over twice as high), the circuit of the larger cone being more than ninety miles.

Coral reefs are far from being all alike, and those of Tahiti have some striking peculiarities. Those bounding Papeete harbour, and the passages leading from it eastwards, which are the only ones that have hitherto been even casually described, are quite a special case even in Tahiti and like nothing that I have seen elsewhere or of which I have read descriptions. So let us examine the corals of a more normal section, such as those at Faaa to the west of Papeete, or on the south coast. In the latter case one is describing what is no longer there, for unfortunately the great flood of January, 1926, caused wholesale death of the corals inside the lagoon.

The best way to see the reefs is by water glass from a canoe; there is just enough water on the lagoon reefs to get a canoe over them, with some scraping at low tide, treatment which would destroy any boat light enough to float in such shallow water. Also in Tahiti any other form of vessel than the native outrigger canoe is hardly ever obtainable.

Starting from shore at sunrise in these islands is an experience which no lover of the beauty of Nature will ever forget, and it leaves with me even more delightful memories than the sunsets over the mountains of Moorea.

One is struck at once by the occurrence of corals only a few yards from shore, and as one passes out, by their abundance over a wide area of reef instead of their being confined more or less to a narrow band along its seaward edge. There is a sudden drop into the deep water of the lagoon, a wall of living coral ten or twelve feet high followed by a steep slope of coral

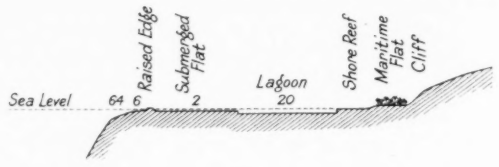


FIG. 5.
SECTION OF THE REEF SOUTH OF TATAA POINT.
The figures indicate depths in metres of the sea below them, the scale of the lagoon being doubled and the trees on the maritime flat quadrupled, in order to make them visible. The author's researches have brought to light the first conclusive evidence as to the structure of the reef.

debris passing out of sight into blue depths. Let us paddle over the reef and along its edge and see what corals are concerned in its formation, deferring awhile the exploration of the reefs across the lagoon and the barrier edge.

The most striking colour of the shore reefs is afforded by bright blue or violet colonies of *Montipora*, in form encrusting or bracket-like with hooked or bushy

branches from their centres, and another form which is chocolate-brown. Otherwise Tahitian corals show little colour except all possible shades of brown. Of forms we have Stag's Horn, bushy and bouquet-like *Acroporas* (*Madrepora*), cactus-like *Pavona*, *Pocillopora* with little bushy or big flattened branches, but generally not much of the more solid forms of *Porites*. At first one is most struck by the great variety of species, but on second thoughts one notices that many which one would expect to see as a matter of course, such as the big solid *Astreans* so conspicuous everywhere in the Red Sea, are not there. While the present article is concerned with the general character of the island, so that detailed description of the coral species must here be omitted, it may be remarked that their distribution in these eastern archipelagoes would be a particularly interesting research. At Rarotonga, for instance, only six hundred and thirty miles to the south-west, we find growing reefs on which a number of the *Astreans*, never seen in Tahiti, are conspicuous.

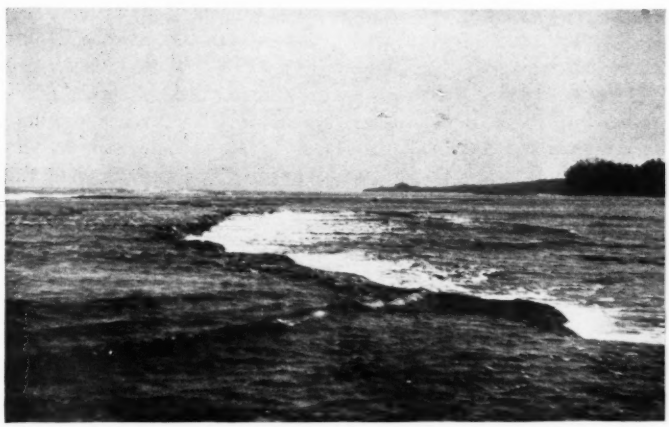


FIG. 6.
VIEW TAKEN ON THE BARRIER REEF EDGE.
The surf has sent over the edge of the coral reef a stream of water which is pouring into the lagoon, sending a wave across to the distant shore. This is an example of the higher part of the edge.

Now let us cross the lagoon, and whether it is a lake-like expanse or a mere channel we shall find the scene completely changed on the other side. Instead of seeing the reef reappear as a cliff of coral coming nearly to the surface there is a bare steep slope of sand, and the reef remains covered by a fathom or so of water, shoaling to three or four feet close to the barrier edge (Fig. 6). This is a long level strip of coral rock, a foot or two above lowest tides, so that in moderately calm weather we may walk for a mile or two between the passes, with the bursting surf on the one hand and the calm lagoon on the other.

Weather permitting we must complete our survey by going through the pass and seeing the outer ocean slope, which descends regularly and rapidly to great depths (Fig. 5). The water is so clear that it is always possible to see plainly to a depth of ten fathoms, and I have had the good fortune to see to nearly twenty. Ten fathoms is, however, enough to show everything, as coral growth ends with curious abruptness at about this depth, instead of extending to the thirty fathoms or so usual on some other reefs. The corals seem different to those of the lagoon, but this is not due to their being of different species but to the way they grow and to the preponderance of some of the stalked *Acroporas*. These are planted out, as it were, each at a little distance from its neighbour, on the nearly smooth and clean bottom.

The general structure of the reefs having been described, we have now to consider its variations on different parts of the coast and the evidences it offers of its history. First of all it is advisable to get a correct idea of the proportionate depths of the water over its different parts. The section given (Fig. 5) shows that the lagoons are extremely shallow in comparison with the ocean a very short distance outside the reef, but it is to be noted that these very shallow and quite small lagoons are as deep, for instance, as most of the seas round Britain, and that depths such as that shown outside the reef are not to be found within miles of any ordinary coast.

This section is almost sufficient by itself to suggest that the reef is one structure from shore to ocean, and that the distinction between reefs out at sea and those in contact with the shore as "barrier" and "fringing" is misleading when applied to these. In Tahiti we have conclusive proof that the reef was once continuous and that the lagoon has been hollowed out secondarily, since we find here and there, on every part of the reef, basaltic stones, lying on the surface or bedded into the coral rock, which certainly reached the outer parts when there was no lagoon channel at all. This has been suspected for many years, but these stones provide the first conclusive proof. There is a long stretch of coast where this is still the case, the lagoon channel ending abruptly at Taapuna Pass about a third the way down the west coast and not occurring again till near the south-west corner.

This is very significant, and taken with certain shore structures and the abruptness of the changes in breadth and direction of the channels generally, strongly suggests that earth movements made at first deep fissures in the reefs which have become widened into lagoons by the erosion of their sides which is often so evident. Currents alone seem quite ineffectual, for they have hollowed the reef of the west coast to only two fathoms or less, forming a wide shallow basin in place of a deep lagoon. I offer this merely as a theory supported by a good deal of evidence, but which does not seem to myself *conclusively* proved, though that there have been subsidences and breakages is shown by the occurrence of filled-in cracks in the reefs in many places.

The reef edge is generally an erosion flat, not one which has grown up in its present condition, much of it being at a level at which no corals can live, not even the specialized stunted forms which constitute its surface where it is only a foot or so lower.

Character of Reef Slope.

The slope to the ocean depths shows several remarkable peculiarities. It is quite regular, not far from smooth, and without any trace of broken coral and sand for the first ten fathoms, these facts showing that the slope is periodically cleaned down by wave motion. As already remarked, those corals thrive best here which by their form—the central stalk supporting the colony above the sand-rasped bottom—are specially adapted to these conditions.

This slope is cut into by a series of numerous natural trenches running straight down from where the surf breaks to a depth of ten fathoms or so where they open out on to the general slope. They are definitely cut, three or four feet deep, with parallel vertical sides, and scoured clean of any sort of growth. In the lower part of their courses they lie at the bottoms of ravines with steeply sloping sides, which are covered with corals *to just the same extent as are the open slopes outside them*. Now if this amount of coral growth were adding *anything* to the reef, and erosion were confined to the actual trenches, these ravines would have nearly vertical sides, and in time the trenches would be obliterated from above and perhaps reopened elsewhere. This is the first proof that the reef is no longer growing seawards. These trenches are entirely different from the buttresses and irregularities formed by outward growth, such as those found to occur, for instance, at Funafuti.

A second proof is afforded by the raised coral flat of the north-west and north-east corners of the island of Moorea. These are the very freshest examples of raised reef rock that I have ever seen or read of, even more so than those of the Red Sea, which have lost much of their surface by wind erosion. This rock is of a dark grey colour, with a level surface about two feet above the water of the lagoon, and shows a *horizontal* stratification, indicating that it is not a consolidated beach formation, though the corals of the surface are all broken or displaced. Scattered over this surface are hummocks two or three feet high each of which is a *Porites* colony *still standing in the position in which it grew*. The whole is simply an exact replica of the lagoon floor, and its original position is certain : it is the outer part of the submerged flat. The preservation of this rock with practically no alteration even after the passage of the centuries since the "elevation" took place seemed to me incredible, but several visits to both localities convinced me that this is the case. Now in both cases these rock flats are situated very near the present reef edge, which is thus shown to have extended seawards not at all since the change of the ocean-level occurred, or if it did it has been worn back again to the position it had at that time.

I have kept the final and conclusive proof to the last, though it was discovered quite early in my exploration. There are generally collections of stones in the bottoms of the trenches, some of which appear to be coral, but others are certainly basaltic. Now these cannot remain long in their present positions on so steep a slope : they may be worked to and fro by the waves but their final motion is inevitably downwards. Hence not only has there been no growth, which would have covered every basaltic stone long ago with coral, but fresh stones are being periodically uncovered by the removal of the limestone in which they were embedded during the period when the reef was growing.

Summary.

To summarize the striking new facts shown by these extremely interesting reefs, we have :—(1) No sure evidence of elevation or depression of the island, except the trifling retreat of the sea-level of six to ten feet. The reefs have attained their barrier form without subsidence. (2) It has been proved for the first time that the lagoons were formed by the hollowing out of the originally continuous reef. (3) That in spite of the presence of corals and lithothamnia the reef is no longer extending seawards, but is actually going back. (4) The sunk reefs are merely those in which this process has gone so far that the upper few fathoms have been removed. They are *not* submerged by local subsidence, nor are they young reefs which have not yet reached the surface.

Progress of the "Discovery" Expedition.

The First Annual Report.

The official investigations on whaling instituted recently took practical form over a year ago, when the S.S. "Discovery" set out for the Falkland Island dependencies. Readers should perhaps be reminded that the expedition has no connexion with this journal.

THE first report* has now been issued of the S.S. "Discovery" expedition, of which the main objective is to make the first serious attempt to place the whaling industry upon a scientific basis. The work is the outcome of an inter-departmental report on research and development in the dependencies of the Falkland Islands, presented to Parliament in April, 1920. Following this a Research Ships Committee was appointed early in 1922 to consider what practical steps could be taken for the provision of two special vessels suggested for the researches.

Official Organization.

For financial reasons it was at that time impracticable to build even a single ship, and the committee was compelled to explore the possibility of obtaining a suitable vessel by purchase. They finally recommended the S.S. "Discovery," which it was considered might be suitably reconstructed, and with its acquisition an executive body known as the "Discovery" committee was appointed by the Colonial Secretary in March, 1923, to carry out the investigations suggested. The committee consists of two representatives of the Colonial Office and one representative each of the Admiralty, the Ministry of Agriculture and Fisheries, the British Museum (Natural History), and the Royal Geographical Society, with Sir J. Fortescue Flannery, consulting naval architect to the crown agents. Sir John Middleton was also a member when he was Governor of the Falkland Islands.

The first two years of the committee's labours were mainly occupied by the reconstruction of the "Discovery," a work which presented many difficulties. Wooden shipbuilding is an art now nearly extinct, and much special material not easily obtainable had to be procured. It was not until the beginning of October, 1925, that the ship left England for her first voyage in the service of the expedition, being styled, with the approval of H.M. the King, "The Royal Research Ship 'Discovery' (Falkland Islands)." Commander J. R. Stenhouse, R.N.R., an officer experienced in Antarctic navigation, had already been appointed master of the vessel, while Dr. Stanley W. Kemp, superintendent of the Zoological Survey of India, was appointed director of research. In addition three zoologists and a hydrologist were engaged for employment on the "Discovery," a naval officer being lent by the Admiralty for the hydrographic survey.

During this period, also, a laboratory was established at Grytviken, South Georgia, for the examination of whales captured at the adjacent whaling station, and although the building was only completed in February, 1925, within two months one hundred and eighty-one whales had been examined. Further, the resources of the committee had in 1925 increased sufficiently to enable them to build a second ship. Since named the "William Scoresby," this is of the whale-catcher type, and is mainly intended to endeavour to work out a method by which whales can be marked; it is also to undertake trawling with commercial trawls and other inquiries into the local fishing grounds. The vessel is also equipped for carrying out, when possible, for purposes of comparison, observations similar to those undertaken by the "Discovery."

Plans for Research.

In addition to the main objective of the expedition, it is hoped by its researches to add to scientific knowledge in other directions, particularly in oceanography, to ascertain the extent and capacity of the local fisheries, and to render service to navigation by carrying out a hydrographic survey of the whaling areas of the Falkland dependencies. Geological and magnetic work were also in view, but it has not yet been possible to make a beginning in those branches of the investigations.

In outlining the programme of the work to be undertaken by the "Discovery" on her first voyage, no attempt was made to define a scheme which should be rigidly adhered to. Much of the work was either novel in character or had to be carried out under unusual conditions, and until the most suitable methods had been tried it was obviously necessary that the procedure should be open to modification as circumstances might dictate.

The amount of direct work on whales which the "Discovery" would be able to accomplish was limited She was mainly required to undertake investigations on the environment of whales, and particularly the

*"Discovery" Expedition. First Annual Report, 1926. (H.M. Stationery Office. 1927. 1s. 6d.).

upply of whale food and the causes affecting its quantity and geographical distribution. To that end the programme provided for a series of routine observations being made at fixed "stations" throughout the voyage. The original plan was to begin work in the Gulf of Guinea, which appears to be the northern limit of the migrations of southern whales, but the postponement of the "Discovery's" departure from England until late in 1925 made it necessary to abandon the contemplated visits to the West African whaling stations. The ship therefore proceeded to Cape Town, calling at Las Palmas and St. Helena on the way. The scientific equipment was tested with generally satisfactory results, and during this voyage the specimens collected included two interesting dolphins (*Steno rostratus*), the skeleton of one of them being sent to the British Museum.

The Second Vessel.

At the close of 1925, then, the "Discovery" was at Cape Town *en route* for her first visit to the whaling grounds of the dependencies; the laboratory in South Georgia or, as it is called, the marine station, had been at work for some ten months; and a second vessel, the "William Scoresby," was under construction. The new ship was launched on the last day of the year, and was so called to commemorate the father and son of that name who were both distinguished as practical whalers, the younger being also a pioneer in the study of whales. His "Account of the Arctic Regions and Northern Whale Fishery," published in 1820, has been described in the "Dictionary of National Biography" as the foundation-stone of Arctic science.

The "Discovery" left Cape Town on the 17th January for South Georgia, and called in at Tristan da Cunha on the 30th. Here mails and stores were landed; on the day following the inhabitants were assembled and a message from H.M. the King was read by the officer commanding. The opportunity was taken to investigate the marine fauna off the island: the hand-lines procured many fishes, one of them (probably *Chilodactylus fasciatus*) being described as plentiful and of excellent flavour. Throughout the voyage to South Georgia the weather was consistently bad and seriously interfered with the scientific programme. On the passage, five deep-water "stations" were made, but no indication was found of the cold submarine current believed to flow northwards from the ice at a depth of about 1,000 metres. At two points on the passage, in 46° 35′ S, and 50° 26′ S, the bottom consisted of "Radiolarian" ooze (shells, etc.), which seems to have been reported previously from the Pacific alone. Whales were seen and became numerous forty miles from Cumberland Bay.

After her arrival on 20th February the ship was engaged in observations on the whaling grounds of South Georgia, where a month's stay was made. Ten days were spent by the scientific staff in cruising on whale catchers and in visiting the shore stations and a floating factory. A matter of great interest is the statement of the director that throughout the season the "Kril" (whale food) found in the stomachs of blue and fin whales consisted of *Euphausia superba*, a single species of small shrimp like crustacean. The coasts of South Georgia are very poorly charted, and during the stay of the "Discovery" as much survey work as possible was undertaken. A special visit was paid to Undine Harbour in order to fix positions at the north-west end of the island.

Port Stanley, Falkland Islands, was reached eventually on 25th April. During a short cruise to the northern end of Falkland Sound quantities of *Grimothea gregaria* were taken, this species—the floating post-larval stage of a decapod crustacean resembling a small lobster named *Munida gregaria*—being said to be the "Kril" of these islands. Leaving Port Stanley on the 20th May to return to Cape Town, the "Discovery" took a north-easterly course in order to pass the reported position of two shoals. High seas frustrated the attempt to make observations on the first of the shoals, and deep soundings only were obtained in the reputed position of the second. On the passage nine full "stations" were made, and large plankton nets were towed at intervening points. At Cape Town, on 29th June, the vessel went into dry dock at Simonstown in order to be fitted with

[*Photo by Russell & Sons, Southsea.*

THE ROYAL RESEARCH SHIP "DISCOVERY."

From this aspect the "Discovery" is seen to be fitted with motor power

anti-rolling keels. The first tour had shown that the heavy rolling which had always been a feature of the "Discovery" was in bad weather a serious hindrance to the proper operation of the scientific gear.

During the stay in Cape Town the scientific staff were fully employed. Their work was greatly facilitated by the hospitality received, laboratory facilities being provided at the University. Special study was devoted to the *Euphausia superba* already mentioned, while the water samples collected by the "Discovery" were examined, research was made into the fat-content of blubber, and progress was made in determining the more important constituents of the South Georgian plankton. Visits were paid to the Union Company's whaling station at Durban, when twenty-one whales were measured, and to the whaling stations of Messrs. Irvin and Johnson (South Africa) Limited at Saldanha Bay and at Hangklip, False Bay—a station that was closed down in 1922 but had lately been reopened. The latter firm also accommodated two members of the scientific staff at the Saldanha Bay Station for about four months. Although whales were scarce, valuable data were obtained, including some very early embryos; the smallest (a Sei whale) was only about 2-3 mm. long, and it is believed that this is the youngest embryo which has ever been found in any whale.

On the 21st September the ship left Simonstown and made two short cruises off the African coast, for work off the Saldanha Bay whaling grounds and in deep water. Africa was again left for South Georgia on the 27th October, the route proposed being south from the Cape to about latitude 58°, where it was hoped to reach finer weather and easterly winds. The programme was upset by exceptional ice conditions, but South Georgia was reached on the 5th December, where the survey of the whaling grounds was resumed.

Meanwhile the laboratory staff had remained at work since the Grytviken station opened early in 1925. The southern winter of that year was devoted mainly to the study of the material collected before the winter began. Whaling restarted about the middle of October, but few whales were caught till Christmas, when they became plentiful. The station was closed down at the beginning of the winter of 1926, by that time (April) the number of whales examined having risen to seven hundred and thirty-eight. The material gathered could not be regarded as complete, however, until observations had been made extending over a whole year, and for that purpose the work at Saldanha Bay, to which reference has already been made, was started in May and carried on until October.

[*Photo by Russell & Sons, Southsea.*

THE "DISCOVERY" UNDER SAIL.

This beautiful ship was once used in the Antarctic by the late Captain Scott, and has now been reconstructed for whaling research.

Observations at South Georgia were resumed early in November, and the information obtained has yielded many important points of interest. Other work done at the marine station includes the chemical analysis of water samples collected by the "Discovery" and investigations on the elephant seals and bird-life of the island. A beginning was also made with observations on the rich fauna of Cumberland Bay.

In order to deal with the collections of scientific specimens gathered by the expedition, an additional scientific officer has been appointed to take charge of and arrange the material, pending the return of the officers who would work on it in this country. Through the good offices of the Trustees the material has been housed at the British Museum (Natural History), South Kensington, where laboratory accommodation has also been afforded.

The plans for the present year (1927) provided for a plankton survey of the whaling grounds at South Georgia to be undertaken by the "Discovery" in conjunction with the "William Scoresby" during January. The "Discovery" was then to visit the other dependencies, the South Orkneys and South Shetlands, and if ice conditions permitted to proceed

further south as far as Neumayr Channel. The passage to the Falkland Islands was planned *via* Cape Horn and the Straits of Le Maire, the ship arriving at Stanley towards the end of April. From Stanley the ship sails for South Africa, which was due to be reached about the end of June. It will then work along the west coast of Africa touching at whaling stations *en route*, arriving home in October. The arrangements also provided that the "William Scoresby" should undertake trawling off the Falkland Islands until May, before leaving for Cape Town and working on whale-marking off the African coast. She will then return to South Georgia in time for the opening of the whaling season 1927-28, when the marine station, closed for the southern winter, will reopen. After a period of leave on their return, and before further work at sea is undertaken, the scientific staff will be employed in this country for some two or three months in working on the collections.

With regard to finance of the expedition, it is pointed out that the expenses of the investigations are met from the revenues of the dependencies. Up to the end of May, 1925, all expenditure was incurred under the direct authority of the Secretary of State for the Colonies, by whom detailed regulations had been drawn up and approved for the management of the investigations and the guidance of the officers. From the 1st June, subject to the general directions of the Secretary of State and in accordance with an approved code of general regulations, the committee were authorized to incur expenditure within the limits of the sanctioned estimates. Up to the end of 1925 the actual expenditure, including the capital outlay on the "Discovery," the "William Scoresby" and the marine station, totalled approximately £190,500, while the approved estimate under all heads for the two years 1926-27 is £126,000.

In conclusion, the report states that the "Discovery" Committee have every reason to be satisfied with the broad and scientific spirit in which the investigations are being conducted by Dr. Kemp and his staff, both at sea and on shore; with the cordial co-operation in the scientific work given by the officers and crews of both ships; and with the rate of progress having regard to the means available. The competent handling of the "Discovery" and the "William Scoresby" has done much to minimize the risks inseparable from an enterprise of this character, and the committee record in particular their appreciation of the skill shown by Commander Stenhouse and his men in navigating the "Discovery" often under peculiarly difficult and trying conditions.

City Tours for Readers.

A NUMBER of *Discovery* readers took part in a tour of the City on 21st June, when Mr. Allen Walker conducted the first party under the new scheme announced in our last number. The response to the invitation then issued has fully justified our arrangement whereby, for the enjoyment of readers of the several journals published by Benn Brothers, a weekly lecture tour will take place throughout the summer. As we pointed out last month, the offices of *Discovery* are situated in the heart of a neighbourhood of exceptional historic interest, the literary monuments in particular being at our very doorstep. From Bouverie House it is possible to walk in a few minutes to all the scenes which have given to Fleet Street a literary atmosphere so completely its own. Associations with Shakespeare, Goldsmith, Dr. Johnson, and Dickens were aroused by the preliminary tours, of which the second was arranged for Wednesday, 29th June. During an afternoon of unique interest under the guidance of Mr. Walker, who is well known through his broadcast talks and as extension lecturer to London University, our guests assemble at Bouverie House at 2.45 p.m., returning for tea about 5.30 p.m. From the list of forthcoming tours given below, it will be seen that these are arranged for Tuesday in one week and Wednesday in the next, to the end of September. No charge whatever is made, but readers should apply to the Editor of *Discovery* for tickets at least a fortnight prior to their intended visit, as the party on each date is limited to convenient numbers.

July.	5th	St. Bride's, Fleet Street (the Printers' Church); "Bridewell Palace" Remains; The River Fleet.
,,	13th	The Royal Courts of Justice; Record Office Museum (containing Domesday Book); Lincoln's Inn.
,,	19th	Priory Church of St. Bartholomew, Smithfield (twelfth century); St. Bartholomew's Hospital.
,,	27th	The Charterhouse; Ancient Carthusian Monastery; Smithfield Market.
Aug.	3rd	Central Criminal Courts; Christ Church, Greyfriars.
,,	9th	St. John's Priory Church, St. John's Gate, Headquarters of the Crusading Order of the Knights of St. John of Jerusalem.
Sept.	7th	St. Paul's Cathedral.
,,	13th	St. Martin's, Ludgate; Remains of London Wall; Stationers' Hall.
,,	21st	St. Andrew-by-the-Wardrobe; Playhouse Yard (site of Shakespeare's Blackfriars Theatre); The Apothecaries' Hall.
,,	27th	"Dickensland": Staple Inn; Furnival's Inn; Old Houses on Holborn; St. Sepulchre's, Snow Hill.

Prediction in Medical Science.

By Professor D. Fraser-Harris, M.D., D.Sc.

Prediction has played an important part in the development of science, and particularly remarkable are the prophecies made in the early days of medicine. Many of these have been proved to be true by discoveries made after centuries of subsequent investigation.

PROBABLY nothing impresses us with the dignity and soundness of science so much as the accurate fulfilling of some one of its definite predictions. In a mathematical science, such as astronomy, prediction may be said to be an inevitable part of the investigator's duties, since the phenomena he deals with are necessarily of a recurring order, but in any science it is a valuable method of putting a theory to the test or of estimating the value of a working hypothesis. For instance, the Russian chemist Mendeleeff, having arranged the elements known to chemists in certain natural series, which nevertheless contained gaps, predicted that before long these gaps would be filled up by elements yet to be discovered. Those of us who have followed the development of chemistry know that these chemical prophecies have come true. The objective reality of those properties on the possession of which Mendeleeff's series was constructed, was thus established.

In the non-mathematical sciences, prediction may be said to be supplanted by prescience or prophecy. Thus, when the great William Harvey wrote to his friend Horst (1654), "Many things still lie hidden . . . destined to be drawn up into the light by the indefatigable diligence of coming ages," he had some, but no adequate, idea of how truly he spoke as a prophet. In a vastly fuller way than he could possibly have imagined, this prescient utterance has been fulfilled. By the "indefatigable diligence" of the great Italian biologist, Marcello Malpighi, Harvey's own generalization as to the circulation of the blood was verified to ocular demonstration by means of the microscope (1660). In a thousand ways have Harvey's words been justified; has not "diligence" triumphed over all the technical difficulties in the way of preserving and analysing the living tissues? Do we not by histo-chemical diligence preserve for ever from decay those very invisible blood-vessels which Harvey's eyes never saw, but which he was so certain existed? How transported with joy would he have been to know that we can fill them with a substance which, solidifying in them, demonstrates their presence with the utmost clearness. Diligence has literally brought them to light; the master's prophetic vision saw that which was invisible.

READERS LEAVING THE *DISCOVERY* OFFICES ON 21ST JUNE.
As described opposite, tours in the City have been arranged for our readers, of which the first took place last month.

Those engaged in studying the intricacies of the nervous system seem at all times to have indulged in prediction. Thus, the father of anatomy, Vesalius himself, ventured to assert (1543) that by mere dissection of the brain no further discoveries as to its functions would be made. Three hundred years of anatomy have justified his belief in the comparative sterility of the study of the gross anatomy of the nervous system, at least as regards the discovery of function. Not by dissection, as Vesalius knew it, but by microscopical investigation, by experimental interference, and by injuries accidentally produced, have the activities of the brain been made clear to us. Vesalius has been justified in his prophecy that dissection is a barren art, but not justified if he meant to predict that the cerebral functions would be for ever beyond the ken of the students of living things.

A most prescient physiologist, the Dane Nicholas Stensen prophesied that, as regards the central nervous system, no further advances in understanding it would be made "without a special manner of preparing it." This was uttered in 1668, and has been completely justified. The preparation of the substance of the brain and spinal cord to fit them for microscopical

examination was surrounded by so many difficulties that not for nearly two hundred years was it possible to make these structures sufficiently transparent. The difficulties in dealing with the cerebral substance were such that they overcame that Alexander of biology, Malpighi, who declared that the brain was a gland which secreted spirits. So far astray is it possible to be led when the time has not yet come for the fulfilment of a prophecy !

Discovery by Experiment.

Yet another seventeenth century prophet, but this time a false one ! The great Sydenham, the English Hippocrates, though a contemporary of Harvey, was not a disciple of Harvey. He saw no use in Harvey's discovery, and consequently ignored it : in particular, he despised the study of the minute structure of tissues, or " histology " as it is called to-day.

Again, according to his scholarly biographer, the late Dr. Payne, Sydenham, prophesied " that the human intellect will never be able to understand the use of the different parts of the brain." Supremely difficult as we know this study to be, surprising advances have been made in it, but just by the experimental method of Harvey rather than by the mere observational method of Sydenham. By that very method of research, the microscopical, which Sydenham trusted least, a very great deal of excellent physiological work has been achieved.

A contemporary of William Harvey and of Thomas Sydenham was a certain Gideon Harvey, " Physician to the Tower," chiefly remembered for his coarse but amusing attacks on the College of Physicians. In what follows he describes the type of doctor of the school of his great namesake, a description which we can imagine Dr. Sydenham fully endorsing :—

" They flay dogs and cats ; take livers, lungs, calves' brains, or other entrails, dry, roast, parboil them, steep them in vinegar, etc., and afterwards gaze on little particles of them through a microscope ; then obtrude to the world in print whatever false appearances gleamed into their eyes ; and all this to no other end than to beget a belief in people that they who have so profoundly dived into the bottomless pores of the parts must undeniably be skilled in curing their distempers."—(" The Conclave of Physicians." Second edition, 1686).

In the same strain of unbelief as to the possibility of histological demonstration wrote no less a man than the philosopher John Locke, a close friend of Sydenham. He committed himself to this :—" That Nature performs all her operations in the body by parts so minute and insensible that I think nobody will ever hope or pretend, even by the assistance of glasses or other inventions, to come to a sight of them."

Professor Osler, in his delightful essay on Locke, tells us a significant fact apropos of this remark : that on the top of the page on which it occurs there is a sentence in Sydenham's handwriting fully confirming his friend's scepticism. In modern language, Locke said there was no future for histology or bio-chemistry, which were futile attempts to unravel the intricacies of texture and of function wholly inaccessible to man. Now it is precisely in these two realms that the greatest conquests in medicine have been made, for the microscope and the test-tube are two of the most powerful weapons in her peaceful armamentarium.

Sydenham was a great physician, a great observer in the realm of disease, but he was no prophet either in his own or any other country. He fell into an error, not uncommon in robust but not broad minds, of imagining that there cannot be anything of much value outside that which these minds readily understand.

Prophecy has always occupied an important place in scientific discovery.

Jenner prophesied that the patient whom he had previously vaccinated against small-pox on being inoculated with small-pox would fail to take it. This was the boy Phipps who had been inoculated by Jenner with the virus of cowpox (vaccinia) on 14th May, 1796, and on the following 1st of July had been inoculated with fluid from a vesicle of a case of genuine well-developed human small-pox : the boy did not take the disease at all. Jenner waited until the 19th of July, and finding that the boy was still quite well, could no longer delay, but wrote to his friend Gardner as follows :—" Listen to the most delightful part of my story. The boy has been inoculated for the small-pox which, as I *ventured to predict* *, produced no effect. I shall now pursue my experiments with redoubled ardour."

A Remarkable Prediction.

One of the most interesting writers on the mind and its organs—the brain and the nerves—Prochaska, of Vienna, makes a remark of great interest with regard to those workers who were to come after him. It concerns the two roots of the spinal nerves. The structural differences between the two roots of a spinal nerve, the upper with its swelling or ganglion, the lower without any ganglion, had long been familiar to anatomists. Prochaska knew that one of the chief nerves of the head, the fifth or trifacial, had also two roots, one large and ganglionated, the other small and non-ganglionated. He was thus led to speak prophetically in the following words :—

" He who shall unravel the uses of the ganglia will also give a reason why the fifth pair of cerebral nerves pass through the

*The italics are mine.—D.F-H.

semi-lunar ganglion (with the exception of the fasciculus which joins the third division) without touching the ganglia, and why only the posterior roots of the spinal nerves enter the ganglia, whilst the anterior roots pass by without any communication with them." (1784.)

Now this was precisely what Sir Charles Bell did twenty-seven years after the above was written. Bell in the first place showed that the upper or posterior roots of the spinal nerves were functionally exactly the opposite of what Prochaska thought them to be, for he thought them nerves whose ganglia prevented them conducting impulses into the nervous system. By conclusive experiments Bell proved that these posterior roots were, in point of fact, the only avenues *into* the spinal cord, and that their ganglia in no way interrupted impulses passing through them.

Of the nature of the nerve-impulse or *vis nervosa* as he calls it, Prochaska wrote in these words:—"Possibly the diligence of the very sagacious observers of Nature may discover whether that principle be electricity or phlogiston or some species of air or the matter of light or something compounded of these" (1784). Many "sagacious observers" since 1784 have done their best to discover the nature of the nervous impulse, and while physiologists would agree that it was not phlogiston or a species of air or the matter of light, not all would so readily put the first possibility out of court. With the formulation of the doctrines of electro-chemistry has risen an attempt to explain nervous activity, not indeed in terms of electricity as we know it flowing in wires, but in terms of electrically-charged particles—ions—constrained to set themselves in certain positions at certain moments in such a manner that electrical phenomena can be manifested.

Prophecy Unfulfilled.

A particularly interesting example of unfulfilled prophecy in biology occurs in the writings of no less a man than Johannes Müller, probably the most encyclopaedic of Germany's scientific encyclopaedists. He has been treating the nature of nervous action, and then he utters the following prediction as regards the velocity of propagation of the nerve-impulse:—"We shall probably never attain the power of measuring velocity of nervous action, for we have not the opportunity of comparing its propagation through immense spaces as we have in the case of light" (1835).

Müller believed, as did other leading biologists as late as 1835, that the velocity of the nervous impulse was something prodigiously great, of the same order of magnitude as that of light; indeed, that the act of thinking was performed with "the speed of light." We still speak of a thought "flashing into the mind," and of things occurring with "the speed of thought." Exactly fifteen years after this prophecy was made, Hermann Helmholtz, in 1850, measured the rapidity of the nerve-impulse in the motor nerves of the frog, and showed it to be perfectly calculable, not much more than about 90 feet a second. He subsequently measured it in human nerves, and found it to be about 120 feet a second. Once again we see the danger of venturing to predict any limitations to the possibilities of experimental science.

An Amateur's Belief.

The last case of prophecy regarding the functions of the nervous system which we shall notice is one by the amateur physiologist, George Henry Lewes, well known as the biographer of Goethe and the first husband of "George Eliot." He ventured to predict that when the posterior roots of the spinal nerves were cut, the erection of the hairs on an animal's back would be no longer possible, in other words, he committed himself to the belief on *a priori* ground that the posterior roots would be found to carry impulses *out* of the spinal cord. Now, with one exception not fully explained at the present time, all the fibres of the posterior roots are devoted to carrying (afferent) impulses *into* the nervous system; so that Lewes's prediction has proved incorrect.

The passages relating to this prophecy are so interesting in more than one respect, that it will be well to have them before us *in extenso*:—

"The posterior nerves being distributed to the skin can, it is obvious, only exercise a motor function in as far as they are related to moving organs or muscles. Now in the skin there are such organs, insignificant enough and only discovered within the last few years; these are muscular fibres surrounding the hair-follicles, and it is these which the posterior nerves cause to contract. If there were no muscular fibres in the skin, the posterior nerves would have no motor function; but they would have the possibility of exercising such a function—the same in kind as that of the anterior nerves. Thus does anatomy assure us that both nerves are sensory and both nerves motor. With this torch in our hands let us enter the otherwise obscure path of experimental inquiry. . . . The conclusion seems irresistible that the muscular sensibility is derived through the anterior or muscle-nerves. . . . There has been no collection of facts to throw light on the movements of the muscular fibres in the skin, but it is worth inquiring what share they have in the erection of 'quills upon the fretful porcupine' or the hairs on the back of an irritated dog. Division of the posterior roots would, I should anticipate, prevent the quills of the porcupine from rising up. But there is no experimental evidence on this subject present. . . . There is no fundamental distinction between the two nerves, both are sensory and both are motor; but they are so in different degrees."

When the late Professor Langley and Sir Charles Sherrington in 1891 came to examine these roots

experimentally, they found the exact opposite of this prophecy of Lewes to be the true state of matters. The "pilo-motor" fibres, as they called them, did *not* pass through the posterior roots, but left the spinal cord by the anterior, so that section of the posterior roots does *not* paralyse the hair-muscles. In fact, there is no real exception to the Bell-Magendie law that all impulses entering the cord do so by the posterior roots, and all impulses leaving it do so by the anterior roots.

The passages just quoted are an excellent example of library or *a priori* physiology. Anterior to all investigation by experiment, the author gets hold of a principle of functional symmetry which he thinks ought to hold good in the case of the two nerve-roots. It is a torch to light up the otherwise obscure path of experimental inquiry! Experimental inquiry, on being made, discovers the exact opposite of what the anatomical light indicated. Therefore anatomical torches by themselves are not to be trusted; and futher, however respectfully *a priori* philosophy should be treated, *a priori* physiology most emphatically is not to be encouraged.

Another definite prediction was Pasteur's regarding the prophylactic inoculations for anthrax in sheep and cattle in 1882. The incident is so well known that it must not be repeated in all its detail. Pasteur had just perfected his method of protecting animals from a virulent disease by repeated injections of the attenuated poison of the same disease. The experimental conditions, prescribed for him by an agricultural society, were that twenty-five sheep were to be inoculated against anthrax, and after an interval to receive a virulent culture of the germs of that disease; at the same time twenty-five normal (uninoculated) sheep were to receive some of the same virulent culture. Pasteur accepted the challenge with equanimity. "The twenty-five unvaccinated sheep will all perish," he predicted, "the twenty-five vaccinated ones will survive"—and lo, it was so. The crowds who came to Pouilly-le-Fort to see the crucial experiment fail and to jeer at the man of science were converted then and on that very spot; and "the whole of France burst out in an explosion of enthusiasm," writes Pasteur's son-in-law and biographer, Valery-Radot.

Fighting the Mississippi Floods.

New Official Plans.

As in the case of the terrible earthquakes of a few years ago in Japan, the sympathy of the whole world has gone out to the sufferers from the floods which have recently inundated so large a part of the United States. But while human endeavour was generally recognized to be powerless against the cause of the Japanese disaster, the thought has not unnaturally crossed the minds of many outside America that surely the flooding of the Mississippi might have been prevented had scientific measures been previously adopted.

It is therefore of the greatest interest to British readers to be informed by Mr. Edgar Wheeler in *Popular Science Monthly* (New York) that in recent times no less than two million pounds has been spent annually in raising the dykes which confine the Mississippi on its southerly course, and that stationed at definite sections along the important river systems are experts of the U.S. Government Weather Bureau, whose duty it is to predict the approach of dangerously high water. There have been thirteen Mississippi floods in less than half a century, and in the present catastrophe advance warnings saved hundreds of lives.

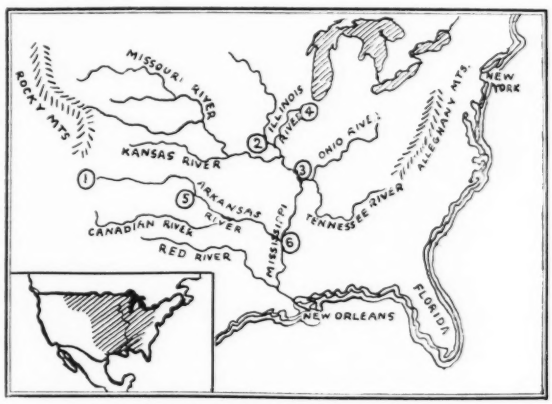
That the Mississippi is the longest river in America is well known, but its size may better be appreciated from the fact that forty out of the forty-eight States are directly affected by the operations now officially proposed for preventing the recurrence of its floods. The awe-inspiring effect of its mighty waters is well depicted by Mr. Wheeler's description of the advancing flood:—

"If, one day late last April, you could have stood in Memphis, Tennessee, watching the crest of the flood sweep slowly by, you would have realized something of its overwhelming power. Two million cubic feet of water flowing past every second—more than a billion gallons every twenty-four hours—the volume of ten Niagaras in a single stream! And if, a few days later, you had been a few miles from Vicksburg, where one of the strongest of the river levees gave way, you would have seen the Mississippi then as an immense overburdened storm sewer, fed by two hundred and forty tributaries with the drainage of two-thirds of the nation's territory.

"In that one stream you would have witnessed the joining of many distant waters, drained from an area of more than a million and a quarter square miles, brought down from as far west as the Rockies, as far east as the Alleghanies, and as far north as the Canadian border!—hundreds of rivers and streams

mingled there in devastating flood tide. Small wonder that embankments of earth and sand should fail to bridle them all ! "

The course of the present floods is indicated by the numbers on the accompanying map, based on a diagram in *Popular Science Monthly*. It will be seen that the first warning came as long ago as August of last year. Heavy rains raised the waters of rivers in Kansas and Oklahoma (1), these being followed in October by damaging floods in the Arkansas and Neosho Rivers in the Kansas prairie region. Then the rains drifted eastward (2), over Missouri, Illinois, Ohio, Tennessee, Kentucky, and the Cumberland valley. Since all this water was at a season when rivers of the Mississippi system should normally have been at their lowest levels, official observers realized then that trouble was imminent. Though the volume of the torrent could not be predicted, it was evident that if the rains of the winter and spring were much above normal, a big flood would result. The worst fears were realized, and late in December more rains swept Tennessee and Kentucky: the Cumberland and Tennessee rivers rose to flood stage (3), in the case of the former all high-water records being broken. In January the winter rains became more widespread, and the Ohio River flooded, by March (4) every one of the Mississippi's tributaries being dangerously swollen (5). Melting snows in the north and in the mountains far to the west and east added to the rising waters, and in April the angry crest of waters began its advance down the lower river (6), producing at flood crest the volume of ten Niagaras !



DEVELOPMENT OF THE MISSISSIPPI DELUGE.

The numbers indicate the sequence of causes leading to the floods, these being described in the accompanying text. The Mississippi and its tributaries drain two-thirds of the United States, as indicated by the shaded area of the map inset.

The proposals now advanced for dealing permanently with the flood menace may be divided into three groups, of which the last—the strengthening of the levees—is likely to be adopted. One plan suggests that huge reservoirs should be established along the main stream and its tributaries; these, however, would render worthless immense areas of rich farm land; their cost would be out of all proportion to the partial relief that might be given; while they could not be relied upon to be empty when most needed.

Another proposal is for spillways at intervals in the levees, with channels to lead the excess water to other streams or to the sea. This, in effect, was the purpose of the engineers recently when they deliberately dynamited the Poydras levee below New Orleans in an effort to save the city by lowering the water-level, but the chief objection is that the relief is only temporary and local.

Reforestation of cleared lands has been suggested, the denuding of forests being held by many as the primary cause of the Mississippi floods, but weather records show that the high waters on the average are no higher than they were half a century ago. Farming, too, has kept the soil broken and at least as permeable to rainfall as forest land.

To-day the levees are little more than banks of earth rising forty feet and more, in some places being reinforced with planking, brush, or concrete piling, and bags of sand. That the reconstruction of the present system is evidently the official policy of the U.S. Government was suggested recently, when Mr. Hoover, Secretary of Commerce, stated: "The feasible means of guarding against future disasters in the lower Mississippi is the adequate widening and raising of the levees on the main river and its backwater tributaries, and the extensions of bank protection, with special treatment in special situations in the lower valley."

Should this proposal be carried into effect, before long great walls of concrete may be erected, rising to a height of fifty feet or more and extending for thousands of miles on both sides of the river and its tributaries. Then would the wide-flung network of rivers, now a menacing flood source, be converted into a great inland system for commercial navigation, with an outlet, perhaps, through the Illinois River into the Great Lakes; thence by way of the projected St. Lawrence waterway into the Atlantic Ocean. New sources of hydro-electric power will also be created.

These are possibilities which eventually may grow out of the present disaster. "Like every other war against a powerful enemy," Mr. Wheeler concludes, "it will not have been in vain if it inspires new determination to build defences that will withstand all tests."

Education Through the Air.

By Edward Liveing, M.A.,

Manchester Station Director, British Broadcasting Corporation.

Continuing from our May issue a general survey of broadcasting—" A New Social Force," Mr. Liveing proceeds to discuss its bearing on education. Writing from inside experience, he is able to throw fresh light on the problems arising from this revolutionizing development.

THERE are still many sections of listeners who look upon broadcasting solely as a medium of entertainment and who are inclined to voice a refrain, which has now become familiar, that " after a hard day's work we expect to be entertained and not educated." Though there are a few broadcasting stations, notably in the United States, which function entirely as the mouthpieces of universities or other educational institutions, the majority of the world's stations carefully cater for their public's desires for recreation. But it is an important fact that there are scarcely any broadcasting systems which do not include in their programmes certain items of an educative nature.

An Unfortunate Word.

The narrow conception of the meaning of the word " education " that has grown up during the last century, as the result of its being applied to, and becoming associated with, the organized education of the community, is embedded in our social consciousness to-day. The unfortunate word has received so many definitions since the publication of Johnson's " Dictionary " that there would appear to be many varying opinions of what it really means. For the purpose of this article I would like to start off by using it in its widest possible meaning, the meaning given to it by John Stuart Mill, who included under it " everything which helps to shape the human being." If we can give to the conception of the word the idea of the individual being led out from himself into new interests, in fact, being brought thereby into greater harmony with the outside world, we shall avoid much of the subconscious feeling which is attracted towards the word no matter to what agency it is applied as, for instance, to broadcasting itself. Many listeners are apt to say to themselves, immediately they hear a talk announced, that they are going to be educated. A hostile reaction to what is subconsciously considered a matter of compulsion sets in, which at once mars any interested feeling that might otherwise have been awakened.

In my first article I attempted to draw a comparison between the Renaissance and the present age, and it is obvious that what the printing press did for that period of civilization—the propagation of new knowledge—broadcasting should not fail to do for this age, in which new ideas and discoveries are taking place every day. The listener, in fact, whether he likes to own it or not, is continually breaking fresh ground even in the ordinary wireless programmes by listening to music, opera and drama which he has not hitherto heard. If we conceive of education more as an adventure and less as a necessary fatigue, less with the utilitarian connotation of the nineteenth century, we should perhaps be able to listen more wholeheartedly to the talks, debates and speeches that the wireless offers to us. The listener needs to attain to that high emotion which Keats felt when first reading Chapman's *Homer* :—

> " Then felt I like some watcher of the skies
> When a new planet swims into his ken ;
> Or like stout Cortez, when with eagle eyes
> He stared at the Pacific—and all his men
> Look'd at each other with a wild surmise—
> Silent, upon a peak in Darien."

Had we lived two centuries ago, and been told that famous scientists, after discovering how matter was composed, would be able to explain their discoveries to the whole world by means of a peculiar agency which enabled them to convey their thoughts to others across space, we should not have believed such a statement. In the gradual establishment of broadcasting as an institution in the life of the day, we should not lose sight of its peculiar aptness, as a modern discovery, for the dissemination of new knowledge and new ideas.

Wireless in the School.

Certain broadcasting systems, notably the British, have instituted for some years past what are known as " broadcasts to schools." Though at first and, in fact, up till within only a few months ago, this side of the broadcaster's activities had little effect upon the curricula of either secondary or elementary schools, there is no doubt whatever now that teachers all over the country are beginning to realize the value of talks by well-known experts on the particular subjects which they have themselves investigated. It is obvious that the broadcast school lesson can never

supplant the work of the school teacher, inasmuch as the personal contact with the pupil is largely missing. These broadcasts have, however, now become part of the curricula of many schools and there are numerous series of talks, such as those of Sir Walford Davies on music, which are regularly received throughout the country, and about which the pupils take down notes, in preparation for examinations which are organized by the B.B.C. and for which the B.B.C. offers prizes. It may be said that, while not supplanting the teacher, these wireless lessons supplement his work in a way that could not otherwise be done, inasmuch as even if the financial means could be found for touring famous scientists, travellers, scholars, or musicians all over the kingdom, there would not be enough to visit every school. Those of us whose school days preceded the era of broadcasting can hardly realize the effects that it must be having in this manner on the minds of the younger generation. Not even pupils in the finest schools in the country had the opportunity of listening on several days a week to talks by men and women who are the acknowledged experts on their various subjects.

A New Technique.

The fact that this new side of the broadcaster's work was not immediately successful should not be put down to the conservatism of directors of education or school teachers; the broadcast teacher himself had to learn his lesson gradually. If you are prepared to spend the time and have a friend who is a teacher in a school that includes in its curricula these broadcast lessons, it is worth while attending a class and listening like the children to a lesson. You will very speedily be able to judge of the merits or defects of the speaker, however brilliant and expert a scientist or scholar he may be.

It is easier to explain the technique of the broadcast school lesson by examples than by generalizations. The wise school broadcaster starts his talk with a slight air of informality, picturing the young audience in front of him in the same way as though he were actually in the place of the school teacher. He bids "Good afternoon" to the boys and girls and perhaps tells a short story or makes some such remark as, "Do you remember that last time we were seeing how such and such a thing was done—(a slight pause) — I fancy that we do not all quite remember, in fact I can almost hear some of you saying that you do not, and so I will just try and recall to your minds in a few words what I was saying. . . . Now I think we are all quite clear and can go ahead with the next stage, which is even more full of interest than the one that I dealt with last week." Then he proceeds with his talk, slowly and deliberately, giving time to pauses after making important statements so that his audience can make notes. Frequently he asks questions, subsequently answering them, though it must be remembered that during the interval between the asking of the question and the answering of it a mental process has been stimulated in the child's mind by the question itself and the mind has attempted to produce some answer to that question. Often, too, he gives instructions that involve some physical action on the part of the children as, for instance, telling them to write down something in their notebooks or to draw a certain kind of figure. It is through methods of this kind and adopting a style of this kind that the broadcast school teacher can overcome to a great extent the absence of his own personality.

Interesting experiments have been made with these lessons in certain schools. The talks have been illustrated by lantern slides brought upon the screen as various points already agreed upon between the broadcaster and the teacher have been made. There is room perhaps for the development of talks which can be illustrated by a school cinematograph so that pupils can listen, we will say, to a well-known traveller describing the exploration of various countries through the loud-speaker, and see the actual scenes of exploration on the screen. The advent of television will undoubtedly have a great effect upon the general influence of these school broadcasts. Meanwhile it is interesting to note that certain British stations supply specially illustrated syllabuses of school talks, which the teacher can either redraw on the blackboard or the children can themselves turn to during the course of the talk.

The Children's Hour.

Apart from this direct education of the child's mind, there is another feature of broadcast programmes that must exercise a far-reaching effect on the growing generation. I refer to the Children's Hour or Children's Corner. This was an innovation introduced in the United States and subsequently taken up by various broadcasting organizations in Europe. Obviously the Children's Hour was an adaptation of the Children's Corner run in many different newspapers in which an "aunt" or an "uncle" writes exclusively for children and also answers their letters. Here, as no doubt American stations realized, was a chance of creating a really vivid and human atmosphere which could not possibly be obtained in cold print, for the young listener was brought into direct contact with

the personalities of "aunts" and "uncles" through listening to their voices. It is exceedingly difficult to say whether the introduction of this rather novel feature into broadcast programmes was a fortune or a misfortune.

Its cultural value depends entirely on the persons who conduct the hour, and it is a regrettable fact that there are very few personalities who can amuse children and at the same time inculcate them with, and stimulate them to, high ideals through the medium of the microphone. Of its success as a means of contact between broadcaster and listener there is no doubt whatever, for it has established an intimate human relationship with thousands of child listeners and older listeners as well, which no other feature in wireless programmes is able to do. If the intimacy so created can be well and usefully employed, its powers for good must be enormous.

Philanthropic Influence.

From a philanthropic point of view alone the Children's Corner, as presented in Britain and in certain dominions, notably South Africa, has been highly successful in inculcating into the child mind desires to help other children, and the many radio circles which have grown up and which consist of child members who, in paying a shilling for their badges, contribute towards funds for the installation of wireless in children's hospitals or towards other charities, have resulted in the accumulation of large sums of money for these objects. Other organizations have been run in connexion with these Children's Hours, bringing together children of all branches of life.

It would, however, be a mistaken policy to judge the value of the Children's Corner purely from the point of view of maintaining a link between broadcaster and listener, or for promoting instincts of unselfishness. When we come to consider its more basic problems this fact will be readily understood. Most reasonable people would say, in answer to the question, "Should the Children's Hour be designed so as to educate children?" that no such direct attempt should be made, but that everything of a second-rate or cheap nature should be eliminated. That is a commonsense attitude which, however, it is extremely difficult to work out in practice. Should we eliminate altogether the strains of modern dance music, or certain moderately good music-hall songs, in favour of the music of famous masters and the poems of great writers? There is, of course, a happy medium in all things, but this medium is extremely difficult to find. Where, too, is the dividing line between really delightful wit and humour, which would appeal to the child mind, and sheer banality? I believe that our real difficulty in conducting Children's Hours satisfactorily lies in the fact that those of us of the present adult generations are so cluttered up mentally with an age which has produced so much that is spurious with so much also that is beautiful and heroic, that we find it almost impossible to hand on a brightly burning torch to the new. That, of course, is a problem which confronts parents and relations of all children quite apart from their wireless "relations." But it is a problem that is in some ways more difficult of solution to wireless "aunts" or "uncles," because during three-quarters of an hour every day they are expected by children to pour out their personalities intensely, wholeheartedly and spontaneously, if they are to make any effect whatever.

Another question that arises affects the title of the artists taking part in this programme. Recent newspaper controversy concerning the elimination of the titles of "aunt" and "uncle" in the Children's Hours will be remembered. Much that was written in the papers and in letters to the papers showed that no real attention had been paid to the more basic problems of this feature. A prominent psychologist, who had children of his own and with whom I discussed this question, gave it as his view that this wireless relationship was certainly not harmful, but served no particular object. Here again we come back to my original statement, and that is that the question very largely depends for its answer on the personalities of the aunts and uncles. In concluding what I have had to say about the Children's Hour, I must admit that my mind is beset with many doubts, and that quite frankly I hope that what I have said will stimulate doubts and questions in the mind of the reader.

The Art of the Broadcast Talk.

Nearly all broadcasting organizations in the world devote considerable space in their programmes to informative talks on all manner of subjects. The northern nations of Europe, in particular Great Britain and Germany, have led the way in this use of wireless. The types of talks offered to the public by the British organization may be classified as follows:—

1. Afternoon topics, which are usually devoted to matters of interest to the housewife, the amateur gardener, and matters of miscellaneous interest.
2. Bulletins of various societies, including the Boys' Brigade, Boy Scouts and Girl Guides, the Royal Horticultural Society, and various wireless societies.
3. Fortnightly critiques of current drama, literature, music and film productions.
4. Topical talks.
5. Adult education talks.
6. Talks on sport.
7. Bulletins or talks arranged in conjunction with the various

Ministries, such as the Ministries of Agriculture, Air, Health and also the Foreign Office, and also with the League of Nations.

It may be remembered that in my first article considerable emphasis was laid on the intimate and individual appeal of the wireless medium. This fact applies to talks more than to any other feature in broadcasting, and the success of a talk very largely depends upon the ability of the talker to transmit his personality to the individual listener. It is inevitable that many speakers are chosen from among those accustomed to lecturing or giving speeches from public platforms. From certain points of view these speakers have definite advantages, and they also have definite disadvantages. They are accustomed to conjuring up interest in the ordinary human being; on the other hand, they are accustomed to dealing with audiences and not with individuals, and it by no means follows that a man who can deal with, and keep the interest of, a crowd can also keep the interest of the individual. Many public speakers who come before the microphone have told me that it is a far greater trial for them to speak to an invisible audience than to a visible one, since they cannot see the effect which they are making at the other end. Though warned most carefully not to consider their listeners as an audience, they frequently, after the first minute of reading their paper, adopt the voice of the public lecturer or speaker. This sounds at once forced, artificial and inhuman to the listener.

Another cause which sometimes makes the broadcast talks appear artificial is the fact that in Great Britain, and also in a number of other countries, a regulation has had to be laid down that all talks should be submitted in manuscript and strictly adhered to,

"THE CHILDREN'S HOUR."

This innovation must exercise a far-reaching effect on the growing generation. concert was broadcast a few weeks ago by the winners in a B.B.C. competition for children, who are here seen in the London studio.

A WIRELESS LECTURE ON BIRDS.

Broadcast lectures by well-known authorities are now one of the educational features in the British programmes. Above is a scene in a London school, showing pupils taking notes from the loud-speaker with the aid of specimens.

word for word, after the censorship of the broadcasting officials. This regulation has been found to be very necessary as the result of public antipathy to certain kinds of statements. It would appear that the effect in particular of controversial matter, in our present stage of civilization, is more liable to inflame emotion than to stimulate thought. There are a number of speakers who find it impossible to read talks in such a way as though they were talking spontaneously, and it is too often the case that the listener can often picture in his imagination the punctuations and the literary artifices of the type-written sentences. The broadcast talker should deliver what he has to say spontaneously, as though he was sitting in the room with the individual listener and talking to him in the course of a conversation, lowering and raising his voice in a natural manner, and repeating those sentences which form the chief statements in his subject-matter. Every possible inflection should be brought into the voice. The best course in preparing a broadcast talk is to dictate the paper that is to be read rather than to sit down and write it, for in this process one adopts a spontaneous manner rather than too literary a style.

Two years ago a Fellow of an Oxford college took me severely to task in a conversation for mentioning the educational aspects of broadcasting. "You cannot educate people over the microphone," he said. "You may be able to stuff their heads with a good many odd and end facts, but education is impossible without the stimulation of argument and discussion." Even if this theory held good two years ago, I doubt very strongly if it holds good to-day. In co-operation with an Adult Education Committee the British organization has instituted what may be aptly termed

a " Broadcast University." Several series of evening talks, specially designed to promote discussion on such subjects as psychology, economics, industrial history, are now regularly arranged for certain evenings of the week. Full syllabuses and ample " follow-up " literature are issued in advance, and a number of adult education societies have arranged " listening groups " among their members. These groups meet regularly, listen to the talks, and subsequently discuss all the salient points in the lectures that they have heard through the loud-speaker. These listening groups are gradually increasing in number, and the potentialities of an organization of such groups throughout the country are too obvious to need any emphasizing.

Wireless Debates.

It should be pointed out that this idea of wireless discussions is not one that has been suddenly conceived and as suddenly put into operation. The British organization has for a long time past considered the need for development in this direction, and to that end has initiated various experiments. One of the most interesting of these experiments was that conducted at the Nottingham Station in connexion with talks delivered by Professors Peers and Wortley of Nottingham University College—an experiment which was, I believe, subsequently tried out also by an American station. The talks were concerned with economics and psychology respectively and, as the lecturers received heavy resultant correspondence, it was decided so to connect the telephone system with the broadcasting station that at the end of each lecture listeners could ring up and put their questions to the lecturer, both the questions and answers being broadcast. The experiments met with a very large measure of success, but showed that, whereas it was just possible to carry through wireless discussions of this nature from a station serving a not too highly populated area, the congestion on the telephone system in larger centres of population would make such attempts for establishing contact between the lecturer and his wireless audience impracticable.

These experiments of 1925 were, however, followed up by wireless debates on matters of general interest arranged between two or more persons at the London, Nottingham, Newcastle, Manchester, and other stations of the British Isles. Some of the more recent debates arranged by the London station either in its studios or relayed from outside halls, between two well-known speakers with a well-known personality taking the chair—such as the debates between Mr. G. K. Chesterton and Lady Rhondda on the subject of work by women outside the home, presided over by Mr. Bernard Shaw; between Miss Rose Macaulay and Dr. L. du Garde Peach on chivalry; and between Mr. Hamilton Fyfe and Mr. Beverley Nichols on the relative pleasures of youth and age—have created a great deal of interest and have served to show that the threshing out of problems of a topical nature between able minds over the microphone does definitely stimulate thought in all sections of the public.

A reference has already been made to the subject of the exclusion of controversial material from wireless programmes in this and other countries. A veto is put on discussions and talks of a highly controversial nature, touching, for instance, on religious and political problems. The whole question of whether such problems should be discussed through the wireless medium is one that presents many difficulties, into which I do not propose to enter in this article. No doubt a wireless treatment of such problems, with more than one side of the question presented to the listener, will materialize in the years to come. " There is much to be said on both sides of an argument," remarked Sir Roger de Coverley, and the man with the fixed idea, as well as the humblest cottager, has certainly learnt the truth of this statement from the debates that he has listened to over the wireless.

In this direction, at any rate, broadcasting has shown that it is an educative as well as informative force, for in comparing the different points of view put before him the listener must stimulate himself to some form of mental process. But apart altogether from discussions and debates, I think it may truly be said that broadcasting offers so wide a variety of food for thought in its talks and programmes that it has become an educative force, the full workings of which in our daily lives are more powerful and more cumulative than we are apt to realize. Assuredly a new planet has swum into our ken, and many of us have become watchers of the skies.

The Growth of Language.

Business Terminology.

We regret to find that in our issue of last month under the above heading reference is made to piracy of the word " tabloid," and that considerable piracy had taken place, which the owners could not prevent. We are glad to have been reminded by Messrs. Burroughs, Welcome & Co. that the word " tabloid " has been their registered trade mark since so far back as 1884, and that shortly after that date they obtained a judgment establishing the word as their trade mark and have consistently upheld it ever since by action in the Courts and otherwise. We tender our regrets to the firm in question.

The City of the Great Chimu.

By C. W. Domville-Fife.

Much research has yet to be made on the remains of the ancient civilizations of Peru, typical of which is the city of rulers who held sway before the famous Inca dynasties of a thousand years ago. The author investigated this little-known site a few months ago.

ALTHOUGH archaeological research has in other lands done so much to piece together gradually the story of bygone centuries from the meagre remains which Mother Earth preserves, so far it has hardly succeeded in raising the veil of mystery which enshrouds the early civilizations of Peru. So it is with the vast ruins of the pre-Inca city of Chan-Chan : twelve square miles of fortifications, walls, palaces, tombs, streets, houses and aqueducts which formed the capital of the Great Chimu, a ruler whose sway extended for many thousands of square miles along the Pacific coast of South America at least five centuries before the Norman conquest of England.

IDOLS AND ORNAMENTS FROM CHAN-CHAN.
These carved wooden objects were taken from the burial chambers or *huacas*, while others made of gold have also been discovered among the ruins

A keen appreciation of the glamour surrounding these little-known and desolate ruins, rather than the possession of any particular archaeological knowledge or skill in research, was the magnet which caused my footsteps to stray into this desert region during a recent journey from Cape Horn to Panama. In order to reach the site of Chan-Chan from Lima, the capital of Peru, it is necessary to take one of the vessels of the Pacific Line from Callao and cruise up the north-west coast of Peru to the sand-encompassed collection of corrugated-iron shanties called Salaverry. Then a short railway, which serves the neighbouring sugar plantations, continues the journey inland as far as the old town of Trujillo, which makes an excellent base for the exploration of the ruins.

After proceeding for several miles up the fertile and irrigated valley of the Moche River, the chaos of mud walls of what was once the greatest city in the western world stretches away as far as the eye can see, covering a barren, greyish-brown plain, closed on three sides by the jagged peaks of the Andean Cordillera. The plain of Chan-Chan is the centre of an almost rainless region, and is subjected the year round to the scorching rays of the equatorial sun. It is this climatic peculiarity which is responsible for the preservation of a thousand-year-old city of mud walls, hardened in a special way when built, and still in places thirty or forty feet high and from nine to ten feet thick.

To say that this region is rainless is, however, incorrect. Once in a long period of years it is visited by torrential floods which have washed away many of the fine coloured paintings, reliefs, frescoes and decorations of Chan-Chan, leaving only the gaunt walls and what lies beneath them as evidence of a gorgeous past. Unless some serious research work is soon carried out in this wonderful region much of interest to the world, and probably of great value to the explorers themselves, will have been lost for ever. Even within living memory one year's heavy rains destroyed a considerable proportion of the finer examples of Chimu workmanship.

While the origin of many of the peoples of equatorial South America has yet to be elucidated, it is known that there were four important states having their headquarters along the coast of Peru before the Inca conquest. The northernmost of these was the kingdom of the Great Chimu, whose capital was Chan-Chan. Although it is not certain that the original name of this city was the same as that given it by the early Spanish historians, it has been discovered that the meaning of the words " Chan-Chan " in the Chimu language is " Sun-Sun," and that the inhabitants were worshippers of the heavenly orb, which makes it more than likely that they called their capital the City of the Sun.

Although Chan-Chan has been known from the earliest times through the descriptions of the Spanish Conquistadores, history helps us but little. The Inca civilization of a later date has eclipsed its

GENERAL VIEW OF PART OF THE RUINS OF CHAN-CHAN.
Decorations in high relief worked in mud-plaster are seen on the wall in the foreground. Remains coloured paintings have been found in the interior of some of the buildings.

predecessors, and we must turn to the ruins themselves and the vast treasure already recovered from the great *huacas* in any endeavour to unravel the past.

It is as much in these *huacas*, or immense structures of pyramid shape situated outside the walls, as in the ruins of the city itself, that interest is found to centre. Apparently these large buildings of sun-dried bricks served as places of worship, for ceremonial and burial purposes. They were in all probability temples dedicated to the Sun God. It is recorded in Spanish archives (1577-78) that many thousands of gold dollars were paid into the treasury of the city of Trujillo as the "King's Fifth" of treasure recovered by the Conquistadores from a single one of these great temples. Later estimates place the total value of the finds in this *huaca*, which was called by the Spaniards *Toledo*, at half-a-million sterling; and there can be little doubt that despite the work of occasional lone treasure-hunters—confronted with square miles of hardened mud and with little if any scientific knowledge—much of interest and value still remains to be discovered.

Legend in the Trujillo region, which has some historical support from early Spanish records, describes the fall of Chan-Chan as being due to the invading Incas and a *ruse de guerre*. It is said that the city was deprived of the water it obtained, by means of aqueducts and reservoirs, from the River Moche, and that the Incas threatened that unless the Chimus capitulated they would take away the light as they had already taken the water.

Whatever truth there may be in this legend, exploration of the whole ruins reveals the existence of an elaborate system of channels and reservoirs for obtaining enormous supplies of water from the Moche River which flows down from the Andean heights. In the centre of Chan-Chan there is the dry bed of one of these huge artificial lakes which measures about two thousand feet in length and two hundred feet in width; another is six hundred feet long, two hundred broad and fifty feet deep. Outside the city there are other even larger reservoirs, evidently used for irrigating the surrounding fields upon which the city depended for its food supplies in an otherwise desert region. A canal leads from the Moche River, through the ruins, to the central reservoir, near to which is a vast building with walls varying from thirty to forty feet high.

There can be little doubt that this structure was the palace of the Chimu emperors. The walls of one chamber within this building measure fifty feet in length, and embedded in the mud are numerous large round stones, evidently inserted with the object of giving greater strength and security. Surrounding this central chamber are a number of smaller rooms, each of which can be entered direct from the larger apartment but apparently in no other way. The theory advanced is that these smaller rooms were for the wives and slaves of the Great Chimu.

Here, as elsewhere in these vast ruins, there is no sign of a roof. Probably shelter was obtained by straw thatching or coloured grass matting, specimens of which have been found in the tombs. Embedded in the walls are long reeds, possibly used to mark the plan of the building during the work of construction. The tops of these reeds show at more or less regular intervals above the mud-brick walls, the consistency of which is almost cement-like in its hardness.

Another large building, of which the use is unknown, is rectangular in form and has forty-five small cells in nine rows. Each cell is fourteen feet long and eight feet wide and deep The natural assumption that

AN UNEARTHED BURIAL MOUND, SHOWING TOMBS.
Of the six tombs here exposed, one has been opened and the mummy and burial objects removed.

these were for prisoners is rather discounted by the fact that these rows of cells appear in the walls of many of the larger buildings within the Chan-Chan area. In some cases they are under a foot broad and deep. It has been asserted that they were used for holding the treasure accumulated by the wealthy, but, so far, most of the golden fish and other ornaments and idols discovered have been found in the *huacas* and other parts of the ruins, and these cells remain one of the mysteries of this ancient capital.

The walls of the palaces and many of the larger buildings still show traces of decoration in high relief, mostly worked in a kind of fine mud-plaster. Coloured paintings have also been found on the inside walls of the *huacas*. Many of the designs bear a striking resemblance to Chinese ideographs, but unfortunately the few remaining decorations were almost entirely obliterated by the last heavy rains of two years ago.

Certainly the most interesting buildings are the *huacas*, or burial mounds. The largest of these is estimated to contain sixty million cubic feet of mud-brick work, but the one which is surrounded by the glamour of romance has already been mentioned and is known as " The Little Fish " (Spanish, *Toledo*). One of the most curious features of these monuments is a circular chamber with round windows usually situated near the centre of the pyramid. Inside this apartment there are signs of what was once an altar, and the light from the setting sun penetrates down a long funnel which passes through the whole thickness of the pyramid into this chamber. In one case, however, the funnel is horizontal and the structure is called locally the " *huaca* of the moon."

All over this amazing city, streets, houses, gardens, baths, reservoirs, palaces, forts and squares can be clearly traced, and, judging from the size and population of mud-built native cities of to-day, such as Omdurman in the Sudan, it could not have sheltered less than a quarter of a million people. That the Chimus were highly skilled in the manufacture of gold, silver and copper is proved by the ornaments recovered. Some of these, which I saw, were of copper, hardened by a process of which the secret has been lost for many centuries. As potters they were also highly skilled, especially in portraying facial expressions. One set of clay images recovered and now forming part of a famous American collection depicts every human emotion from supreme agony to unalloyed bliss.

Chan-Chan to-day is a city of the dead. Only the warm wind of the tropics rustles the tiny particles of coarse sand which break away from the walls of its ruins, over which there broods an awful silence.

Correspondence.

" COAL GAS AS AN ILLUMINANT."

To the Editor of DISCOVERY.

SIR,

In the article on this subject by Dr. de Mouilipied, in your June number, the following paragraph occurs:—" The issue of inflammable gas from the earth is a phenomenon which must have been noted by many who have left no record of their observation. In the early years of the seventeenth century, there is evidence that Jean Tardin made such an observation with regard to a ' fountain which burned ' near Grenoble."

May I be allowed to say that Tardin did rather more than " make an observation." He remarked upon the presence of coal near this source of gas and also distilled an " oil " from bitumen and other substances and heated it to produce an inflammable gas. The account of his experiments and observations were published in 1618 at Tournon with the following title :—" Histoire Naturelle de la Fontaine qui brusle près de Grenoble, avec la recherche de ses causes et principes et ample traicte des feux souterrains." A copy of this work is, or was, in the National Library in Paris. It seems therefore the claim that Dr. Clayton was the first to record the fact that the distillation of coal would produce an illuminating gas should be held in suspense until Tardin's work has been re-examined.

Yours faithfully,

EDWARD A. BUNYARD.

Allington, Maidstone.

THUNDER IN THE TROPICS.

To the Editor of DISCOVERY.

SIR,

I have read Mr. C. Britton's letter commenting on Amazon Valley problems in which he mentions that " thunder can seldom be heard above twelve miles from the flash."

Under Australian conditions this certainly does not hold good, as it is common to hear the roll of thunder up to thirty miles, and more under favourable conditions, such as obtain during the latter dry months of the year. Using a watch and compass I have definitely located storms up to twenty-three miles, the time elapsing between a brilliant flash and its corresponding roll of thunder being timed, and its distance calculated; the exact location—or path—of the storm being afterwards checked up by observation.

No doubt the sound travelling such long distances is accounted for by the dry atmosphere, and level country free of hills. It is noticeable that thunder cannot be heard here nearly as far during the wet or monsoonal season, as during isolated thunderstorms in the latter portion of the year when the atmosphere is in a much drier state.

Yours faithfully,

H. K. SHEPHERD.

The Plains,
Townsville, N. Queensland,
Australia.

Mr. Britton, whose letter commented on above was published in our December issue, writes :—

" There can be no doubt that, providing meteorological conditions are right, thunder *can* be heard over great distances, but these occasions are, in general, uncommon. In ' Distribution of Thunderstorms over the Globe,' Dr. C. E. P. Brooks states

that 'in favourable circumstances thunder can be heard for a distance of ten or twelve miles,' but observations have been made of thunderstorms which were audible at greater distances, even in this country. In these cases, however, the atmospheric conditions are undoubtedly exceptional. Mr. Shepherd emphasizes in his letter that the unusual audibility of thunder only occurs under special conditions and rightly suggests that the dryness of the air is a conditioning factor. Humidity has a very remarkable effect upon the transmission of sound even over fairly short distances.

"THE MYSTERY RELIGIONS."

To the Editor of DISCOVERY.

SIR,

The able and most interesting article by the Rev. James Wall in the April number of *Discovery* brings to mind a theory put forward a year or two ago by Miss Jesse Weston in her book "From Ritual to Romance." This author suggests that the legend of the Holy Grail may possibly be the exposition, in the form of a story, of the ceremonies and doctrine of one of the mystery religions—perhaps the Orphic—which had lingered on in the west after the departure of the Roman legions who had introduced it.

In a field where imaginations have often run riot Miss Weston handles critically and cautiously the material that she has collected, and brings out many striking parallels which are equally interesting whether we accept the derivation of the Grail legend from a mystery religion or regard the story as the expression of a similar but independent tendency.

The early versions of the legend, in which the Grail heals the maimed (or emasculate) Fisher King, and at the same time restores the fertility of the wasted land, suggest the common purpose of the mysteries; while the obligation placed upon the hero to ask the guardians of the Grail a question about its meaning recalls the questions of the Neophyte to his instructors at a ceremony of initiation. The purity of the knight who is privileged to see the Grail may well correspond with the purification of a candidate for initiation, and the meal which appeared miraculously after the revelation of the Grail with the ceremonial meal of the mystery religions.

The Grail is described, in the earliest versions of the story, as a bowl with a lance bathed in blood standing upright in the centre, and, whatever its connexions with the mystery religions may have been, it was certainly an apt symbol with which to express a concept of life that is almost universal, and as such it may very well have been once used in a material form as an instrument of sympathetic magic.

Yours, etc.,

F. A. HAMPTON.

Chesham Bois, Buckinghamshire.

A PHYSICS MODEL FOR SCHOOLS.

To the Editor of DISCOVERY.

SIR,

In Mr. T. Barton Kelly's account of the Physical and Optical Societies' Exhibition in the February number of *Discovery* there appears an interesting account of a model illustrating wave motion. It is part of my duty to inspect science teaching in high schools and technical schools in Tasmania, and I have frequently observed the difficulties encountered by students in clearly grasping the principles of wave motion. The model referred to in the article would appear to be of especial value for class demonstration, and I venture to write in the hope of securing further information. If the apparatus is made by any firm, perhaps you would kindly supply me with the firm's name and address; if not—and we would, of course, prefer to make up the apparatus ourselves—could you kindly arrange to let me have a sketch of the apparatus as set up in the exhibition, with sufficient details of dimensions and materials to enable its reproduction?

Yours truly,

FRANK ELLIS,

Superintendent of Technical Education.

Tasmania Education Department,
Hobart, Tasmania.

Mr. Barton Kelly writes:—

"The exhibition of the model aroused a good deal of interest in educational circles, and the inventor, Mr. T. B. Vinycomb, approached a firm of laboratory apparatus makers who will probably undertake the manufacture of the device with a view to making it available for schools and colleges. At the moment the matter is under consideration, and inquiries will be dealt with by Mr. Vinycomb, whose address is 139 Shooter's Hill Road, London, S.E.3."

FORGED PICTURES DETECTED BY X-RAYS.

(Under the above title the following was published in the course of a recent correspondence on judging old masterpieces.)

To the Editor of THE TIMES.

SIR,

Principal Laurie remarks in your columns this morning on the evidence of the X-ray as showing in the case of a certain forged picture that the panel had been put together with modern wire nails. A further use of the X-ray now being developed in this connexion in America was recently brought to my notice by an Italian correspondent, who described researches which an official of the Fogg Museum of Harvard University was making on the masterpieces in certain European galleries.

The principle of this new method is that while the X-rays are stopped by the mineral colours which were formerly used, so that the paintings appear as a shadowgraph, the vegetable colours employed in modern work are transparent to their light. Not only is the detection of forgeries said to be readily aided in this way, but interesting evidence of the artist's technique is also obtained, through the exposure of the character of the underpainting or preliminary work done before the surface was finished.

Yours faithfully,

JOHN A. BENN,
Editor of *Discovery*.

154 Fleet Street, E.C. *20th May.*

The researches described above were the subject of an editorial note last November. Two instances of pictures detected by X-rays have been mentioned in the June *Burlington Magazine*, since this letter was published. A strong Franz Pourbus (*c.* 1580)—now in the Metropolitan Museum of New York—was discovered in this way beneath a superficially pretty Flemish portrait, while an evidently repainted head in a canvas by the Italian master Tintoretto (1518-94) was found to conceal a fine characteristic one beneath. The subject is dealt with in *Discovery* this month, in an article by Mr. Hughes.

Among the Stars: A Monthly Commentary.

THE HEAVENS IN JULY.

By J. A. Lloyd, F.R.A.S.

THE accompanying chart represents the aspect of the principal star-groups and planets as seen from London on 1st July at 10 p.m. and on the 31st at 8 p.m. The centre of the map marks the point overhead and the boundary the observer's horizon. Planets visible this month are the following: Venus, rapidly

approaching greatest brilliancy, and at greatest elongation east of the sun on the 2nd of the month. On 5th and 6th July she will be observed close to Regulus, the principal star in Leo. Mars will also be near Regulus towards the end of the month, though he will be above the western horizon for only a short time after sunset. Jupiter will be a brilliant object in the east after midnight, while Saturn can be seen low down in the southern sky at about 10 p.m. He is in the constellation Scorpio. The time employed above is Greenwich mean time, not summer time.

Developments in South Africa.

A significant modern development in astronomy is the concentrating of attention on South Africa as a site for large observatories. During the past two years several large telescopes have been erected in the Union, the latest being a 27-inch refractor, belonging to the University of Michigan, which is now in course of erection near Bloemfontein. Another American observatory, Harvard, has also removed one of its big instruments, the 24-inch Bruce refractor, from its former position at Ariquipa, in Peru, to Bloemfontein. Altogether there are now five great telescopes within the boundaries of the Union, besides several others of quite respectable dimensions—more large telescopes, *per capita*, according to Dr. Schlesinger, than in any other country. Taken as a whole, conditions for observations in South Africa are equal to any obtainable elsewhere. With all these fine instruments in full work we can hope for a substantial increase in our knowledge of the southern heavens in the near future.

It has been said that the gigantic apparatus of the modern astronomer tends to have a discouraging effect upon the humble amateur, working with small and often crude apparatus. As a corrective to this idea, perhaps it may be mentioned that the first photographs of the comet Grigg-Skjellerup on its return this year were secured by an English amateur, Mr. F. J. Hargreaves, who employed an aeroplane lens of twenty inches focus mounted on a home-made equatorial. Strangely enough, plates of the same region taken the same week at Yerkes and Harvard College Observatories, failed to show any trace of the comet. This is not, of course, the first instance where the so-called "back-yard" astronomer has been ahead of his professional brother.

Comet Pons-Winnecki, after passing perihelion last month, is now moving rapidly southwards, and preparations are being made in the southern hemisphere to receive it. At the Melbourne Observatory the great 48-inch reflector, which has been idle for forty years or so, is to be brought into commission for spectrographic observations of the comet to be undertaken by Mr. Z. A. Merfield. This great telescope was made by Thomas Grubb & Son, of Dublin, about the year 1870, and is said to be of great optical perfection.

Measuring Star Distances.

Attention is called in a new Harvard Bulletin (No. 846) to the variable star CG. Sagittarii, discovered by Bailey in 1924. This star has been studied carefully by B. Gerasimovic at the Harvard Observatory, who finds it to be a normal Cepheid with a period of sixty-four days. It was explained in these notes in January last how the real luminosity and hence the distance of a Cepheid variable star can be deduced from its period. The distance of the present object is about 125,000 light-years, which is said to be the remotest isolated *stellar* object known. The use of the word stellar should be noted, for it has recently been stated by Dr. Hubble that the smallest of the spiral nebulae shown by the great 100-inch telescope are situated at a distance of no less than 140,000,000 light-years, approximately. The light-year is the space traversed by a ray of light travelling at 186,000 miles per second for one year.

The velocity of light has thus come to be a fundamental factor in all questions relating to star distances. It has hitherto been accepted as 186,325 miles per second, or 299,860 kilometres per second. The method employed to obtain this value by Professor Michelson at Mount Wilson, was to reflect a beam of light from a rotating octagonal mirror to a plane mirror situated twenty-two miles away, the speed of rotation of the first mirror being so adjusted that the returning beam from the distant mirror was received on a succeeding facet of the octagonal mirror. A simple sum in arithmetic then gave the time occupied by light in travelling the double journey of forty-four miles, the speed of rotation of the octagonal mirror being known with great accuracy. The experiment has been repeated recently with slightly modified apparatus, and the final value adopted by Professor Michelson is 299,796 kilometres per second. The Professor, however, hopes to secure still better results by removing his plane mirror to a distance of eighty-two miles, thus providing a longer path for the beam.

Book Reviews.

Manual of Meteorology. Volume I: "Meteorology in History." By Sir Napier Shaw, with the assistance of Miss Elaine Austin. (Cambridge University Press. 30*s*.).

The most notable factor operative in moulding the early course of civilization was undoubtedly climate. Primitive peoples become what they were largely as the outcome of their reaction to their climates; the vagaries of the weather formed a part of the environment which was of paramount importance in determining the customs, the character, and the history of ancient races. The facts of weather, rain and sunshine, cold and heat, storm and calm, and the impressive phenomena of thunder and lightning were always present to their observation. Speculation as to the nature, origin and recurrence of these phenomena strongly coloured ancient religions and mythology, and the climates of the various seats of early civilizations are reflected in the respective religious observances. This is to be found very clearly in a comparison of the mythologies of Greece and Egypt.

In the book under notice, Sir Napier Shaw tells us the story of meteorology in history. His survey is from the earliest records known to exist, to the complex systems and agreements which make up the international synoptic meteorology of the present day. The most primitive meteorological science was the accumulated experience finding expression in the traditional times of sowing and harvest, of bad and good navigation, and in the rudimentary weather lore found in the earliest classical writings. In Chapter IV a number of well-chosen extracts illustrate this early meteorology, its characteristic feature being the ascription of the phenomena to the control of some personal deity. Yet the beginnings of a scientific treatment of the phenomena of meteorology are to be found in the writings of the Greek philosophers, and we have the first important landmark in meteorological history in the treatise of Aristotle entitled *Meteorologica*. This remarkable work covers a much larger ground than the modern term "meteorology" connotes. Only fifteen of its chapters relate to meteorology proper, and the data which Aristotle collected from many sources can be regarded as a presentation of the state of knowledge in his time. Indeed, for twenty centuries afterwards the science was at a standstill and the classical speculations of Aristotle upon weather phenomena and his explanations of them remained in sole possession of the field of thought.

It is of interest to compare the climate of the Mediterranean basin deducible from these early writings with that shown by modern records. Sir Napier devotes a chapter to a resumé of the present climate, the results being set out in a series of maps and tables, and reaches the conclusion that, generally speaking, the climate now is similar to what it was in the time of Herodotus. A further chapter is set apart for the evidence upon which opinions have been formed as to changes of climate that have occurred in specific localities during the historic period.

Very little progress was possible during the 2,000 years after Aristotle, a period which Sir Napier Shaw calls the age of weather lore. The science had as yet no instruments. Its chief feature during this long time was the vast numbers of rules, based more or less upon experience, which were used as guides to the vagaries of the weather. The second outstanding date in the history of meteorology is the year 1643, when Evangelista Torricelli invented the mercury barometer. This date can be said to mark the birth of the exact science of the physics of the atmosphere. Developments came now upon two lines. The physics of gases generally began to be studied and understood, and the collection of data commenced, although in an imperfect way, in the keeping of meteorological diaries and records. In order to give a *coup d'oeil* of the progress of meteorology after the invention of the barometer, the author, in Chapter VIII, gives brief biographical details of those workers whose names are chiefly associated with the development of the science from 1643 up to 1850.

The year 1850 can be taken as the third great landmark in the history of meteorology. It was about this time that the Daily Weather Map came into existence. This was made a practical possibility by the use of the electric telegraph which rendered quick collection of synoptic observations a comparatively easy matter. Also the systematic study of the upper air, the most noteworthy development of meteorology in recent years, can be said to date from about the same year. The latter half of the book deals with the development of meteorology during this modern period, and a chapter on upper air research includes a series of very fine reproductions of cloud photographs.

The whole work embodies a vast amount of research and is written in the scholarly style that we have learned to expect from Sir Napier Shaw. The format of the book is excellent; the plates and diagrams, essential features of a good meteorological treatise, are well and clearly reproduced, and there is a compendious index. The book is undoubtedly an indispensable one in any meteorological reference library and should not fail to be read by all students of meteorological science. It is a splendid introduction to the series of volumes which will make up the "Manual of Meteorology."

C. Britton.

The Biology of Fishes. By Harry M. Kyle, M.A., D.Sc. With 77 Illustrations and 17 Half-tone Plates. (Sidgwick & Jackson. 16*s*.).

Dr. Kyle has written a fascinating and well-illustrated book on fishes. Perhaps of all groups of the vertebrata the fish vary most in their structure, and this variation is the source of the philosophy of the book, which is of considerable interest. The author departs to a considerable extent from the orthodox views of the followers of Darwin; but he is able to quote that great naturalist as taking, at any rate to some extent, the same view that he does. He writes in his Preface that

"The possibility that characters have arisen at variance with the innate tendencies of "Heredity," and persisted without the aid of "Natural Selection," is a thesis which requires some courage to state. Yet this is one of the deductions that come, it seems to us inevitably, from a study of fishes, and a few words of explanation may be given here."

He adds a third factor to those, which are usually supposed to dominate the making of form and structure, *i.e.*, Heredity and Environment. To these he adds Activity. He thinks that inheritance is perhaps of less importance amongst fishes than in the higher vertebrates, and supports this conclusion by reference to the greater variability of their characters; characters which are very sensitive to changes in external conditions. In fact, the constancy of the species is due in his opinion only to the persistence of a normal environment. To his third factor, *i.e.*, activity, he attributes the appearance of new characters."

"The plastic material that contains the traditions of the past responds in an elemental manner to the new impressions, and the resultant characters may be, have frequently been of such a totally different appearance that the genetic relation cannot be discerned.

"The ancestors of the fish swam in the water before the structures distinctive of a fish developed. The earliest fish record of the rocks, perhaps 400 million years old, shows only the impression of muscles grouped as in a fish, nothing solid about it."

The structure of fishes, their fins, their skeleton, their gonads, and all the other organs which make up the body of a fish, are adequately dealt with. But the book goes far beyond the ordinary anatomical treatise. It has, for instance, a very interesting chapter on the migration of fishes. The young are borne about by currents and helplessly drift hither and thither. After a time the young fry are able to resist the currents, and can either remain stationary or swim freely about in all directions. This they do in order to obtain food. But the true migration of fishes is different. Something impels certain genera, such as the eel and the salmon, to make long and frequently dangerous journeys, sometimes half across the Atlantic. The tunny is a well-known example of a migratory fish. From Aristotle onwards literature is full of references to the seasonable occurrence of this favourite food fish in the Mediterranean. Dr. Kyle points out that the watchman on the hill overlooking the sea, mentioned in the Bible, is possibly a reference to those who awaited its arrival, whilst the ancient outlook-ladders and the fishing-gear seem not to have been modified for 2,000 years. Classical writers thought that the tunny migrated from the Atlantic into the Mediterranean, passing along the north shore of Africa to Egypt and Palestine and then into the Black Sea. Here, in the Sea of Azov, it was believed to spawn and then return along the southern shores of Europe out into the Atlantic again. But recent investigations have shown that both young and adults are present in the Mediterranean waters at the same time, and Pavesi has been led to believe that the adult tunny lives most of its life in the deep waters away from the coasts, rising by a vertical migration to the surface near the spawning time. Thence they move towards the shallower waters. It is indeed a vertical and not a horizontal migration which takes place; and the ancient writers were probably mislead by the migration towards the shallower waters to spawn. At present the best tunny fishing-ground lies outside the Straits of Gibraltar in the Bay of Cadiz. It harbours the larger fish which have already spawned on the Spanish or Portuguese coast which follow the sardine and mackerel shoals northward, where they are frequently taken with a haul of herrings.

There is a full discussion of luminous fish, and mention is made of that curious genus *Anableps* of Central and Southern America, where the eye is divided into two horizontal halves by a cross-band of conjunctiva. The pupil beneath this is similarly constricted into an upper and lower part. This fish lives on the surface, and probably the top part of the eye is adapted for vision in the air and the lower for vision in the water. A similar arrangement exists in some aquatic insects.

One of the most interesting sections of the book deals with the breathing organs. No one who has seen the common rudd, with its fins and tail of haemoglobin-red, can doubt that breathing is not entirely confined to the gills, which are at times supplemented by other organs. Some fresh water fishes have a greater need for oxygen than others, and many such as the minnow come to the surface because there is more oxygen there. If they kept down by a grate they perish. The lung fishes also must have regular gulps of air. Some fishes have lung-like pockets or sacs which contain air immediately derived from the atmosphere. Possibly the air sac is a modification of some such structure, although in certain forms the air which it contains has practically no trace of oxygen at all.

Altogether this book is a valuable contribution of icthyology. It is full of interesting facts well set out, and it is sufficiently up-to-date to contain a remarkably interesting account of Dr. Tate Regan's investigation on the parasitism of the male on the skin of the ceratiid fishes. This is not merely a formal adhesion, but the tissues of the male and female actually fuse into a common mass, the union being even more complete than those of the tissues of an embryo in the uterus of its mother. The vascular system of the female becomes actually continuous with that of the male. Most of the organs of this inconspicuous male parasite are absent. It takes no food by its mouth, and the digestive organs remain undeveloped. There is apparently no liver, and it seems doubtful even if kidneys exist. It is, in fact, but little more than a sac of spermatozoa.

A. E. S.

The Broken Trident. By E. F. SPANNER. (Williams & Norgate. 7*s.* 6*d.*).

"The Broken Trident" is an interesting fantasy. Coming from the pen of a retired naval constructor it commands attention in its treatment of recent tendencies in naval vessels, and in this respect supplies valuable criticism of the extravagancies into which the material school have been beguiled and for which the taxpayer has to foot the bill. The author's thinly-veiled condemnation of the enormous tonnage, excessive speed, multiplication of "gadgets" and contrivances which characterize modern naval material, the natural product of the craze for "research," will meet with the approval of a large and growing body of naval opinion. In this respect, therefore, Mr. Spanner has made a valuable contribution to a very vexed question, particularly valuable from one who served under the late Lord Fisher, the philosophical father of the extreme materialism which the author so clearly condemns.

Like Mr. Wells he is seeing light, and is learning that "scientific" and engineering marvels may be white elephants, the herding and maintenance of which lead towards bankruptcy without fighting efficiency. When, however, our author turns from material of which he knows a good deal to sea-strategy of which he clearly knows nothing, the usual fallacies of the amateur seaman appear. He misinterprets the lessons which the errors of the late war should teach. Like the veriest tyro, he is ignorant of the first principles of sea-power, principles which the discovery of steam has buttressed, and no discoveries of "science" have invalidated.

Turning from the naval aspect of this "shocker" to the "aerial vision" which inspires the book, it is pleasant to find our author on the side of honour, decency, and civilization, and pointedly dissociating himself from the prevailing aerial mentality which frankly, if not enthusiastically, accepts a return to methods of warfare which would disgrace a world of savages. Mr. Spanner has the wisdom to perceive what many exalted personages are foolish enough to overlook. He perceives that sound strategy is synonymous with integrity and honour, and never opposed to these primitive virtues.

But here praise for Mr. Spanner's book must cease. While in his eyes the potentialities of aircraft development are so terrible that he sees no other course than the abandonment of war, his aerial vision is compact with the usual vague talk, innocent of fact and untouched by reason. Our author is quite unconcerned with physical law. Like others he assumes mechanical flight to be "in its infancy," but wisely refrains from indicating in what direction any radical improvement of of engines or planes may be sought. While rightly reproving

the naval tendency to regard mere size and speed as progress, when he takes to himself wings, vast speed and size in aircraft excite his enthusiasm. The fantastic aerial vision which "The Broken Trident" conjures up, however, seems likely to be dispersed by "The Great Delusion," a book which, though perhaps less thrilling to the general reader, has the advantage of being based upon physical laws and facts which as yet do not appear to have been seriously disputed in any quarter.

"NAVAL OFFICER."

The Absolute at Large. By KAREL CAPEK. (Macmillan & Co. 7*s.* 6*d.*).

There is a type of book that has been labelled "the scientific romance," and since the early days of Mr. H. G. Wells there have been few books of this order written that could boast even a hint of genius. But the creator of the Robots, Karel Capek, has put into novel form an idea of such staggering originality that his new book towers head and shoulders in merit above the fantastic fiction of the last few years. Mr. Wells has dealt with the same theme in "The World Set Free," a pre-war vision of civilization embarrassingly endowed with vast gifts of energy following successful experiments in atomic disintegration.

Mr. Capek visualizes a machine which uses up the entire atomic energy contained in a piece of material, and this "karburator," as it is called, can provide vast supplies of power from one shovel full of coal. But it has a most difficult by-product, which is "chemically unanalysable, immaterial residue, which shows no spectrum lines, neither atomic weight nor chemical affinity, no obedience to Boyle's law, none, none whatever, of the properties of matter." On the assumption that all matter contains the Absolute in some state of confinement, the complete destruction of any piece of matter releases an imprisoned force, a psychic force, that has a most disturbing effect on the human mind. It induces religious mania, and as "karburators" are manufactured on a large scale, the released force makes a most devout, communistic mess of civilization, until the vigorous revival of every form of religion passes to a militant phase, and in the names of all the gods that men have feared and honoured in the past, wars are made, and holy massacres and reigns of terror staged throughout the world.

Some people will describe the book as blasphemous; others will find the ambling, desultory chapters and the rather unskilful English of the translation tiring, but discerning readers will recognize in this strange blend of humour and sadness a bitter comment on humanity and human institutions.

JOHN GLOAG.

The Location of Mineral Fields. By M. H. HADDOCK, F.G.S., A.M.I.Min.E. (Crosby, Lockwood & Son. 9*s.* 6*d.*).

Even in these days of statistics and estimates, it would tax all the resources of an experienced and confident man to form any reasonable conclusions regarding the amount of money which has been squandered, in England alone, on "wild-cat" mining adventures. Speculators have risked their money with men having little or no mining or geological knowledge, and in many cases the so-called location of mineral wealth has been nothing more than mere guesswork. This state of affairs is partly due to the small amount of reliable literature hitherto available on this subject.

The book under review, written by one who has had a long and practical experience, is intended to help fill this gap in scientific literature. It is a valuable clearly-written textbook with a wealth of excellent diagrams.

It has been said that in reading a map the student must try to *feel* the surface relief and *see* solid. In other words, he must visualise the country and also obtain a clear mental picture of the rocks and strata forming the area. In the more purely geological parts of the book the diagrams are particularly good, and Mr Haddock has helped the reader to obtain this mental picture by means of cleverly-executed pictorial representations. The reader would be well advised to transpose chapters IV and V in this section of the book, and thus acquaint himself with the facts in a more easily assimilated sequence. The pages on subterranean contouring and borehole surveys will be of particular interest to the pure geologist. On both these subjects, which are of increasing importance, it is difficult to obtain reliable and concise information, and many will be grateful for the facts here gathered together. The chapters more intimately concerned with geophysics are again of practical value. By following the methods described the location of a mineral field becomes a matter of scientific accuracy instead of haphazard guessing The calculations are given in as simple a manner as possible, and for the guidance of the non-mathematical mind, intermediate steps are frequently inserted.

It would be an advantage if the titles of the works quoted at the close of each chapter were given in greater detail. For instance, the reference given on page 130 as "Q.J.G.S., London, 1922," is ambiguous, even with the named volume at one's side. The book, however, has a good index and at the moderate price at which it is published should find a place on the shelves of everyone interested in our mineral wealth.

F. S. W

Analysis of Coal and its By-Products. Technical Research Series of Catalogues, No. 5. (Baird & Tatlock (London) Ltd.).

In view of the conflicting political arguments on the coal industry now before the public, the value of scientific data on coal and its by-products cannot be over estimated. Whatever views may be held on the future conduct of this vital industry, the necessity for getting the most out of its products is nowhere in dispute. As is pointed out in the preface to the catalogue under review, the value of the results obtained by the experts working on this problem can be fully realized only with the co-operation of the makers of scientific apparatus; to this end standard types have been devised, and designs of the latest equipment approved for use at H.M. Fuel Research Station are here included. As little publicity has so far been afforded the investigations now in progress, it may be of interest to quote a recent official announcement.

An important aspect of the work, this states, undertaken by the Department of Scientific and Industrial Research, is a survey and classification of the coal seams in the various mining districts by means of physical and chemical tests in the laboratory, supplemented where desirable by large scale tests at H.M. Fuel Research Station, East Greenwich, or elsewhere. The Fuel Research Board of the Department consider that the best way to carry out this work is by means of local committees representing the local colliery owners and managers, the local branch of the Institution of Mining Engineers, the Fuel Research Board, and the Geological Survey of Great Britain, as well as outside scientific interests. Each committee is charged with the duty of supervising the work of the survey in a coal-mining area; and in this way the survey becomes of practical value from the commencement, since local knowledge and experience are made available, and the seams to be investigated and the general programme of work are decided by those who are able

to estimate most correctly the relative importance of the problems to be solved. The seams selected undergo physical and chemical examination by local investigators appointed for the purpose, after which a final selection is made of those seams likely to justify experiments on a technical scale in order to test their suitability for particular uses or methods of treatment.

Committees are actively at work in Lancashire and Cheshire, South Yorkshire, Nottinghamshire and Derbyshire, and North Staffordshire, while another committee is dealing with the coalfields of Scotland. A further body has now been appointed to deal with the coalfields of Durham and Northumberland.

(1) *How Insects Live: An Elementary Entomology.* By W. H. WELLHOUSE. (The Macmillan Co. 21*s.*).

(2) *Insects of Western North America.* By E. O. ESSIG. (The Macmillan Co. 42*s.*).

(1) Darwin divided naturalists into "wholehoggers" and "hairsplitters." The American entomologists mostly belong to the latter group but, whatever merits there may be in dividing insects into as many Orders as possible, we think that textbooks of the type under review should be written by "wholehoggers," whereas the author seems to belong to the other group, and we think that, for the type of student for which the book is professedly written, a number of these Orders could have been suppressed.

The author's idea is to give some knowledge of the twenty-four Orders included by taking a few types "instead of giving . . . short generalized accounts of families." The possibility of giving an adequate idea of an Order by describing a few types is perhaps open to question, but the descriptions of the types chosen are good and the book reads very pleasantly. There is no bibliography, but at the end of each chapter a few books of reference are mentioned. The chapter on suggestions for collecting insects is inadequate, and we don't like the key at the end of the book.

(2) This is a book with many excellent qualities, not the least of which is the number and clarity of the illustrations. There are 1,035 pages, but the paper is thin and of good quality and the whole volume is well got up. There are twenty-eight chapters, of which the first three are on Arthropoda, Arachnida, and the Classification of Insects respectively, while the remainder deal each with an Order of insects. The author states that the classification adopted "is an attempt to reconcile the modern ideas with the more conservative ones," but the methods adopted to attain this end may not be altogether appreciated by entomologists on this side of the Atlantic. However, the book is really excellent, and the facts stated and the keys scattered throughout it will be found very useful.

F. BALFOUR-BROWNE.

A Short History of Marriage. By EDWARD WESTERMARCK Ph.D., LL.D. (Macmillan & Co. 10*s.* 6*d.*).

"The Golden Bough" and "The History of Human Marriage" are conspicuous examples of books which, starting as modest works within the compass of the ordinary reader, have grown in successive editions to encyclopaedic proportions through the accretion of fresh evidence, either illustrating or extending the application of the authors' theories. In both cases these theories have had so marked an influence on the trend of intellectual culture outside the narrower limits of anthropological science, that the issue of some form of abridgment in each case was almost an imperative necessity. The larger works, by their mere bulk and their vast range of evidence, had become almost exclusively the hunting ground of the specialist. We have had a shorter "Golden Bough," and now Professor Westermarck has issued a "Short History of Marriage."

The book is no mere abridgment. Our welcome is the more cordial on this account. In it Professor Westermarck, while using the fifth edition of the larger work as a basis, treats marriage purely as a social institution. With his accustomed lucidity and cogency of argument he sets forth his most lately formulated views upon the origin and development of human marriage in all the variety of forms in which it exists or has been known to exist among primitive peoples and its function as an element in society. To those who are interested in the study of the more serious problems of human activities, whether in their political, social, or economic aspect, no more fitting introduction could be offered than Professor Westermarck's book.

E. N. F.

Our Early Ancestors. By M. C. BURKITT, M.A., F.S.A., F.G.S. (Cambridge University Press. 7*s.* 6*d.*).

In this book Mr. Burkitt has had a task of extraordinary difficulty. He undertakes to give an account of the cultures of the Mesolithic, Neolithic, and Copper Ages, placing them in proper perspective in the history of civilization by a brief account of the periods immediately preceding and following them—namely, the Palaeolithic and Bronze Ages. He has courageously attempted to introduce to the study of these later periods something of the systematic treatment which the earlier palaeolithic period has received; but the conditions of investigation and discovery to a great extent preclude the like precision of statement and comprehensive grasp of the subject. Time, in bringing to light further evidence, may do much to remove these difficulties. Indeed, in the study of the period immediately following on the palaeolithic period—the Mesolithic period as Mr. Burkitt terms it rather than "Epipalaeolithic" as some prefer—sequence in type and character of culture are beginning to emerge more clearly almost day by day as the result of closer and more continuous study. These remarks, however, describe the material and do not criticize the author. Notwithstanding the fact that at times he appears cramped for space, perhaps inevitably, Mr. Burkitt is an admirable guide through a maze of material of which the interpretation is often still in the realm of hypothesis.

E. N. F.

A Year amongst the Persians. By E. G. BROWNE. With a Memoir by SIR E. DENISON ROSS. (Cambridge University Press. 25*s.*).

This record of "impressions as to the life, character, and thought of the people of Persia," was the result of a journey made in 1887-1888, and after being out of print for many years is now reprinted for the first time. It has been described as "one of the world's most fascinating and instructive books of travel." The author was a great authority, perhaps the greatest of his day, on Persian literature, and in many ways a striking and attractive personality. Even in those early days when he set out on his travels, his sympathy with and understanding of the Persians of all classes and types was remarkable. Persia then, as we can now see, was approaching a critical phase in its career as a nation, and those who have followed its history in recent years can see in the graphic but faithful picture which Browne drew the first very faint shadows of the events which were to come. It is a great book, reproduced in a worthy and enduring form for which all credit is due to the press from which it comes.

E. N. F.

Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge, for the Academical Year, 1925-1926. Published by Authority, 1927. (Cambridge University Press.)

The interest of this little publication lies not so much in the abstracts themselves—of which the scientific ones in particular are, of course, highly technical—as in the fact that it is the first to appear under a new scheme likely to prove of the highest importance to research within the Empire. The preface points out that the Board of Research Studies of Cambridge University has for some time been considering the question of the publication of short summaries of dissertations approved for the degrees of Ph.D., M.Sc. and M.Litt., the higher doctorates being awarded not on theses, but on published work and at a later stage in a graduate's career. Such summaries should not only lead to a more general reference to the dissertations themselves which are deposited in the university library, but will constitute a complete and readily available record of the research work accomplished in the university under the direction of the degree committees and the Board. It is also hoped that their publication may assist future research students, both at Cambridge and elsewhere, to formulate their schemes of research, preventing overlapping and the repetition of work in directions that have already been explored by previous workers.

The desirability of the issue of such a record has recently been emphasized by the outcome of action taken by the Universities Bureau of the British Empire, as a result of which many other universities within the Empire propose to take similar action and the establishment in the near future of a complete university research intelligence service appears likely. The publication just issued begins the Cambridge record with the academic year 1925-1926, each summary having been approved by the examiners or by the student's supervisor, and it contains a convenient index which refers both through titles of dissertations and through authors' names.

Animals Looking into the Future. By WILLIAM ALLISON KEPNER, Professor of Biology in the University of Virginia. (The Macmillan Co. 7*s.* 6*d.*).

Professor Kepner, of the University of Virginia, has written a learned little work on biology—not exactly an elementary work, for he does not explain many of the technical terms; but a second year student of the subject would gain a great deal by reading it. The Professor deals largely with habit and function, and is particularly good on the feeding of the amoeba and other amoeboid-like unicellular animals. The purposeful way in which they attack their food and reject substances of no food value is fully brought out and the illustrations of these and of the other animals in the book are of very high quality. He deals with the farsighted methods by which moths fertilize the *Yucca* so that their larvae may feed on its seeds, and the way in which other ants cultivate fungi for future food. And he recalls the fact that although for fifty million years ants have been fossilized in amber, they had at that time "developed all their various castes just as we see them to-day, their larvae and pupae were the same, they attended plant-lice, kept guest beetles in their nests and had parasitic mites attached to their legs in the very same peculiar positions as in our living species." He points out how many resources of insect life have been developed independently of each other, and tells us that social organisms have arisen on at least twenty-four different occasions in nearly as many natural families or sub-families belonging to five different orders of insects. Altogether a book that makes one think.

A. E. S.

Books Received

Melanesians of the South-east Solomon Islands. By W. G. IVENS, M.A., Litt.D. (Kegan Paul. 30*s.*).

A History of European Diplomacy, 1914-1925. By R. B MOWAT, M.A. (Edward Arnold & Co. 16*s.*).

A Treatise on the British Freshwater Algae. By the late G. S. WEST. New and revised edition in great part rewritten by F. E. FRITSCH. (Cambridge University Press. 21*s.*).

Handbook of Photomicrography. By H. LLOYD HIND, B.Sc., F.I.C., and W. BROUGH RANDLES, B.Sc. (George Routledge & Sons Ltd. 16*s.*).

Readable School Biology. By O. H. LATTER, M.A. (G. Bell & Sons Ltd. 2*s.* 6*d.*).

Isaac Newton, 1642-1727. A Memorial Volume edited for the Mathematical Association by W. J. GREENSTREET. (G. Bell & Sons Ltd. 10*s.* 6*d.*).

Janus: The Conquest of War. By WM. MCDOUGALL, F.R.S. (Kegan Paul Ltd. 2*s.* 6*d.*).

Plant Autographs and their Revelations. By SIR J. C. BOSE. (Longmans, Green & Co. 7*s.* 6*d.*).

Some Fundamental Problems of Cellular Physiology. By W. J. V. OSTERHOUT. (Oxford University Press. 4*s.* 6*d.*).

Stars and Atoms. By A. S. EDDINGTON, M.A., D.Sc. (Oxford University Press. 7*s.* 6*d.*).

Evolution in Science and Religion. By ROBERT MILLIKAN. (Oxford University Press. 4*s.* 6*d.*).

A Manual of Automatic Telephony. By C. W. WILMAN, A.M.I.E.E. (Crosby, Lockwood & Son. 7*s.* 6*d.*).

Light. By V. T. SAUNDERS, M.A. (John Murray. 6*s.*).

The Nature of Man. By G. A. DORSEY. (Harper & Bros 3*s.* 6*d.*).

Social Factors in Medical Progress. By B. J. STERN. (Columbia University Press, New York. $2.25).

The Credibility of Herodotus' Account of Egypt in the Light of the Egyptian Monuments. By WILHELM SPIEGELBERG (Basil Blackwell, Oxford. 2*s.* 6*d.*).

Abstracts of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees in the University of Cambridge for the Academical Year, 1925-1926. (Cambridge University Press)

Concise Geometrical Conics. By C. V. DURELL. (Macmillan & Co. 4*s.*).

Inorganic Chemical Synonyms and other Useful Data. By ELTON R. DARLING. (D. van Mostrand Co., New York. $1.00).

The Diary of Henry Teonge, 1675-1679. Transcribed from the original manuscript and edited by G. E. MANWARING. (Geo. Routledge & Sons Ltd. 12*s.* 6*d.*).

The Book of the Sea. By T. C. BRIDGES. (George G. Harrap & Co. 7*s.* 6*d.*).

The Interpreter Geddes: The Man and His Gospel. By AMELIA DEFRIES. (Geo. Routledge & Sons Ltd. 10*s.* 6*d.*).

Cruising Around the World and the Seven Seas. By STANTON D. KIRKHAM. (G. P. Putnam's Sons Ltd. 12*s.* 6*d.*).

The Logic of Modern Physics. By P. W. BRIDGMAN. (Macmillan & Co. 10*s.* 6*d.*).

Alternating Current Electrical Engineering. By PHILIP KEMP, M.Sc.Tech. (Macmillan & Co. 15*s.*).

Why Get Cancer? By H. REINHEIMER. (Grevett & Co. 2*s.* 6*d.*)

Atoms and Molecules. By R. M. CAVEN, D.Sc., F.I.C. (Blackie & Son Ltd. 7*s.*).

Comparative Physiology of the Heart. By A. J. CLARK. (Cambridge University Press. 8*s.* 6*d.*).

The Genetics of Sexuality in Animals. By F. A. E. CREW. (Cambridge University Press. 10*s.* 6*d.*).

The Psychology of Character. By DR. A. A. ROBACK. (Kegan Paul Ltd. 21*s.*).

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